TESI^ APPROVAL STATUS FORM

JUDUL: SPARE PARTS INVENTORY MANAGEMENT SYSTEM

SESi PENGAIJAN: 2004/2005

Saya GAN CHUN HOU (HURUF BESAR)

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^ Tesis dimaksudkan sebagai Laporan Projek Sarjana Muda (PSM)
SPARE PARTS INVENTORY MANAGEMENT SYSTEM

GAN CHUN HOU

This report is submitted in partial fulfillment of the requirements for the Bachelor of Information and Communication Technology (Software Development)

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY
KOLEJ UNIVERSITI TEKNIKAL KEBANGSAAN MALAYSIA
2004
ADMISSION

I admitted that this project title name of

SPARE PARTS INVENTORY MANAGEMENT SYSTEM

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STUDENT : ___________________________ Date : 19/10/04
(GAN CHUN HOU)

SUPERVISOR : _________________________ Date : 19/10/04
(NOOR AZILAH MUDA)
DEDICATION

I am as ever, especially indebted to my parents, Gan Cheong Seong and Tey Siew Tuan for their love and support throughout my life.
ACKNOWLEDGEMENT

I wish to dedicate the most sincere thanks to my dearest supervisor Noor Azilah Muda for her invaluable editorial support, encouragement, supervision and useful suggestions throughout my meaningful accomplishment of the project. Her reputable moral support and continuous guidance enabled me to complete my tedious work and tasks successfully.

I would like to express profound gratitude to my Industrial Training Program supervisor who acted as my advisor, Prof Madya Dr. Shahrin Sahib, for his valuable support and useful advices on any modifications during the development of the project.

I am highly thankful to my Intel Technology Sdn Bhd supervisor Neoh Seng Chye, Chin Weng Wai, Foo Guoay Hua, Lee Teck Ee and all the Manpower Staffing Services (MS) from PG6 manufacturing production floor for helping me to verify the Tester Interface Units Tracking System using Spare Parts Inventory Management System tool effectively as well as for their valuable suggestions and instant feedbacks throughout the verification. I am grateful for the invaluable chances and experiences that I have gained through this meaningful collaboration between the two good reputations organizations such as University College and Intel Corporation for developing the project in order to enhance the current system effectively.

Finally, I wish to express my appreciation to Ainne Tan, who guides me with the direction of the Final Year Project at the very beginning.
ABSTRAK

Semasa menjalani latihan industri di Intel Technology Sdn Bhd, laman Web Spare Parts Inventory System telah dilaksanakan untuk Tester Interface Unit Tracking System dalam kilang pembuatan bagi memastikan unit dikawal dengan baik, tiada komponen yang rosak, menjimatkan kos dan mengurangkan masa mesin rosak dan meningkatkan produktiviti. Sistem ini dilaksanakan bagi menyediakan satu sistem kawalan dengan komputer pangkalan data untuk mengatasi masalah, pemuangan, mengawal semua Tester Interface Unit komponen. Manakala, sistem yang telah dilaksanakan mengalami masalah seperti kelajuian untuk proses data, menyatukan barkod modul dan kelemahan yang seterusnya serta cadangan lain untuk membaiki laman yang sedia ada. Perisian yang dibangunkan ini akan menggantikan sistem yang sedia ada disebabkan masalah-masalah tertentu. Syarikat Intel akan memperoleh keuntungan misalnya meningkatkan pendapatan tahunan, menjimatkan kos dengan perlaksanaan perisian yang dibangunkan ini. Model Waterfall bagi pembangunan perisian telah digunakan semasa membangunkan perisian untuk menyelesaikan masalah yang dihadapi berdasarkan metodologi yang sesuai dengan keperluan sistem. Akhirnya, peluang antara kerjasama Kolej Universiti Teknikal Kebangsaan Malaysia dengan Syarikat Intel amat dihargai semasa pembangunan perisian bukan sahaja dapat memperingkatkan produktiviti syarikat tetapi juga dapat memperkenalkan nama dan imej Kolej Universiti melalui kerjasama akademi dengan industri.
ABSTRACT

During the industrial training at Intel Technology Sdn Bhd, the Spare Parts Inventory Management System tool web-based application has been implemented for Tester Interface Unit Tracking System in the manufacturing production floor in order to ensure the units handling process in control, no damage to components, cost saving and reduce unnecessary downtime, man hour to repair and improve the productivity. The implementation actually is to set up one central location with Personal Computer database to manage issuing, returning, maintaining and close monitoring of all the Tester Interface Unit components. More inputs need to be gathered for improvement on system, process, cost, productivity and others. Based on the feedbacks throughout the verification, there are some concerned areas about the Spare Parts Inventory Management System that need to be improved such as the network speed, barcode printing integration, inefficiency of the existing system; some proposed key features and others. The enhanced software project will be developed to replace the existing web-based application due to some issues that always brought inconveniences and problems, which have been affecting the current system as well as the productivity. Intel Corporation can achieve typical benefits such as increase annual sales, realize annual cost savings and reduce inventory costs through the improved software project. The Waterfall Software Development Model has been applied on the developed software project that will address those inefficiency issues effectively according to the right project methodology and system requirements. Finally, this is a precious dream-come-true opportunity collaboration between Kolej Universiti Teknikal Kebangsaan Malaysia and Intel Corporation working closely on this project not only for Intel’s manufacturing production floor enhancement but also to boost up University College reputation and bring out the best public image. This will certainly make University College a good fame for improving Intel Corporation manufacturing production floor system.
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CHAPTER I

INTRODUCTION

1.1 Overview

The Spare Parts Inventory Management System (SIMS) will be developed to handle Intel Corporation manufacturing production floor. This chapter briefly discusses about the introduction, problem statements, objectives, scopes, contributions, and expected output of the project.

1.1.1 Project Background

Inventories include goods purchased for resale, internal usage, or consumption. Inventory management is a complex matter, involving governing laws, operating rules and regulations, administrative law rulings, recommended practices, designated procedures, and specific conflict-of-interest provisions. In addition to all of these compliance issues, the entity must also ensure that "enough but not too much" inventory is available. Management controls over the recording, reporting, and safeguarding of inventory items are necessary.
During the industrial training at Intel Technology Sdn Bhd (assigned under the Network Communication Chipsets Operation Six (NCO6) Assembly, Test and Backend Engineering’s Tester Engineering Group supervised by the Intel Corporation’s PG6 group leader Chin Weng Wai), among the given tasks the SIMS tool web-based application for Tester Interface Units (TIU) tracking system has been implemented in the PG6 manufacturing production floor. TIU serves as an interface between tester and units being tested which becomes the most important feature of tester for chipsets manufacturing at Intel Corporation production floor.

The system was implemented in order to ensure the TIU handling process in control, no damage to components, cost saving and reduce unnecessary downtime, man-hour to repair and improve the productivity. Actually, the SIMS tool is a web-based application called Spare Parts Inventory Management System developed by NCO automation group to manage test hardware inventory such as Tester Interface Units, Standard Units, load boards, conversion kits and hand clamps. The SIMS tool currently only manages TIU module. The SIMS tool consists of four main modules:

1) Transaction
2) Search
3) Super user Login
4) Logout

The SIMS tool will scan the barcode sticker on each TIU for tracking purposes such as location and inventory. After the implementation, there were some instant feedback about the SIMS tool implementation such as the speed of network slow, the barcode printing portion was not integrated into the web-based application, the user interface design is not easy to use, no email triggering, no auto keeps track of pogo pin counter due.

Based on the feedback, the idea of the Final Year Project is to duplicate the functionality of Intel’s existing proprietary SIMS tool web-based application to
SIMS tool stand-alone simulation software and added desired enhancements in some key areas in order to improve the existing SIMS tool to be more effective.

1.1.2 Project Description

SIMS tool stands for Spare Parts Inventory Management System. Actually the develop SIMS tool is a stand alone software that contains Tester Interface Units (TIU) module tracking system. The SIMS tool consists of five main modules:

1) Transaction - perform basic check in, check out, routine maintenance (RM) and repair of TIU.
2) Search - search TIU information by transaction and inventory.
3) Super user Login - accessible only to super users. From there, the users can add/update/delete user, add/update/delete supplier, and add/update/delete TIU and print barcode for TIU.
4) Barcode Printing – print out barcode sticker for the new TIU using the printer.
5) Generate Report – generate out the transactions report to be printed using report wizard.

There are some proposed key features of the system to solve the problems that occurred in the existing SIMS web-based application:

1) Capture every transaction operations such as check in, check out, RM (Routine Maintenance) and Repair.
2) Search by transaction and inventory.
3) Super user login for database administration such as add/update/delete of users, suppliers and products as well as barcode printing.
4) Email triggering to notify staffs or suppliers to replenish items.
5) Display interactive graph as an indication for product inventory.
6) Auto keeps track of the pogo pin counter due.
7) Integrate barcode printing portion into the stand-alone software.
8) Generate out the transaction report to be printed out using report wizard.
9) Telephony function that enable super user to call the supplier directly without using the phone but using modem and microphone to communicate.

The inventory modules are designed to provide up-to-date information to Intel Corporation in order to improve decision making, reduce inventory levels, and maintain tight operating and auditing controls over its operation. These modules allow the manufacturing to plan effectively for future purchases by analyzing problem areas.

1.2 Problem Statement

During the implementation of the Spare Parts Inventory Management System (SIMS) web-based application, the training session has been provided to the users. Among the feedback, the speed of network at the production floor is slow estimated around five mega byte per second. The SIMS web-based application is not a stand-alone software application; it needs to connect to the server. Therefore, the application is slow to load the Active Server Pages (ASP) pages to run the transaction operations. In addition to that, the speed of network is slow at the production floor has also become the issue of inefficiency in processing the transaction operations.

There is no email triggering to notify staffs or suppliers to replenish the items in the existing SIMS web-based application. When the stock inventory has been checked, there will be issue lack of stock when the device owner does not replenish
the items. The lack of stock will certainly affect the productivity and the cost savings.

The SIMS web-based application need to add auto keep track of pogo pin counter due feature. When the pogo pin counter due has reached 150000 units, it indicated that the specific item needs to change the pogo pin. If the pogo pin counter due has more than 150000 units without any knowledge, the items will easily encounter components damaged issue. Damaged components definitely will cause the machine down and affect the productivity as well.

When the new items have been transferred into the production floor, they need to have the barcode sticker as their unique product name. This barcode ID will make the transaction operations more effective. However, the barcode printing portion is not integrated into the web-based application. The printing barcode function needs additional software to support. This has caused inefficiency of printing the barcode.

1.3 Objective

The goal of the SIMS tool will be developed to automate the spare part for Tester Interface Units (TIU) tracking process at Intel Corporation manufacturing production floor.

The main objective of the SIMS tool implementation is to set up one TIU central location with Personal Computer database to manage issuing, returning, maintaining and close monitoring of all the TIU. This will assist the TIU handling process in improving control of spare parts used in preventive maintenance, no
damage to components and cost saving. The software application also will ensure the entire TIU get proper repair to reduce the risk of TIU components damage.

Actually, the SIMS tool is to prevent unnecessary down time and man hour to repair when spare part such as TIU not available issue. This develop software is used to achieve zero missing TIU and it will certainly save a lot of expense as one TIU costs amount of money around RM38000. Therefore, the system will automatically report to personnel in charge when the TIU trigger duration is reached. It has become an automated reporting tool for managers and paperless recording system.

There are some proposed key features of the system added into the develop software. The purpose of the added key features will be developed to replace the existing SIMS tool web-based application due to the less effective of the transaction operations.

1.4 Scopes

Manufacturing today is becoming increasingly competitive. Production processes have been squeezed for the last pound per hour, for one more component per shift. The production equipment itself is one of the few remaining areas in plant operation where significant gains can be made.

To maintain the manufacturing leadership, it is necessary to move from a defensive strategy of maintaining the status quo to a proactive, aggressive plan to improve plant reliability and capacity. Therefore, the Spare Parts Inventory
Management System (SIMS) will be developed as a useful tool to manage the production assets in a systematic and professional way.

The SIMS stand-alone software tool will be developed to replace the existing proprietary of SIMS web-based application that was currently implemented the Tester Interface Units (TIU) tracking process at Intel Corporation manufacturing production floor. The project will be developed to capture all the TIU transaction operations such as check out, check in, routine maintenance (RM) and repair. The system will record all the transaction operations that could be searched by inventory and transaction in order to keep track of the current location of TIU easily.

The system will have super user login for the administrator to manage the database administration such as add, update, delete as well as barcode printing. The system will be added with the email triggering function; whereby the system will send email to the device owner as a notification to return the TIU that was still in the status of check out to replenish the items. The device owner will check in the TIU using the SIMS tool to update the TIU status.

Moreover, the system will be displaying an interactive graph as an indication about the summary of the product transaction operations. The graph will show how many products that have been checked out and checked in as well as product inventory. The system will auto keep track for the pogo pin counter due. For every transaction, the user needs to fill in the pogo pin due. If the pogo pin is more than 150000 units, the system will prompt out the message to require for changing pogo pin. Or else the system will not allow proceeding for the next transaction.

The project will be developed to integrate barcode printing portion into this stand-alone software. The stand-alone software will be able to print out the new barcode for the Product ID whenever there is a new product been added into the database. The software will include the report wizard to generate out the transaction
report to be printed out according to the search by transaction and search by inventory.

1.5 Contributions

The software application will be developed to automate the Tester Interface Units (TIU) tracking process in order to ensure the TIU handling process in control, no damage to components, cost saving and reduce unnecessary downtime as well as man hour to repair. The software application also will ensure the entire TIU get proper repair to reduce the risk of TIU components damage owing to the TIU components are very expensive. The TIU that has not received any proper repair certainly will affect the productivity due to the down time.

Besides that, the development of the SIMS tool stand alone software will be used to achieve zero missing TIU and it will certainly save a lot of expense as one TIU costs amount of money around RM38000. Currently Intel Corporation manufacturing production floor cater about 300 pieces of TIU. The develop software will capture complete TIU transaction history that able to auto keep track of TIU inventory. Therefore it is easy to locate TIU and Standard Units and can ensure TIU and Standard Units in tip top condition.

The SIMS tool web-based application is currently implementing at Intel Corporation manufacturing production floor. However, it is not a stand-alone software application, the speed of network in production floor is slow about five Mega Byte per second (Mbps), the stand alone software will be developed to make the processing job faster and more effective. User-friendly interface design of the software will be easy to use.
Barcode printing portion will be integrated into the develop software to make the printing job easier and more convenient. It saves a lot of time from printing the barcode using separated software to support. There is interactive graph that will always display all the transaction status and inventory for the TIU provides the fastest and instant information for the users.

All the TIU have the pogo pin counter due that indicate certain TIU need to be cleaned or changed new pogo pin when the counter unit over 150000 units. The software will be developed to auto keep track the pogo pin counter due and prevent the TIU check out by owner before clean or change new pogo pin. This auto keep track pogo pin counter due will certainly reduce less damaged TIU components and improve the productivity.

1.6 Expected Output

There is an existing Spare Parts Inventory Management System (SIMS) currently implementing at Intel Corporation’s PG6 manufacturing production floor that handle test hardware inventory. During the implementation, the users’ feedback has been collected after the system started operating for few months. Based on the feedback, there are some issues need to be addressed accordingly.

Among the issues are the speed of network which is slow about 5 Mbps, no email triggering to notify supplier replenish the items, no auto keep track of pogo pin counter due, the barcode printing portion is not integrated into the web-based application, the search by inventory and transaction is not effective enough, inconvenience to generate the inventory report and other inefficiency module.
During the last stage of the project, the expected output would be realized after the useful and beneficial proposed solutions which are going to integrate into the developed software to address the issues that caused inefficiency of the web-based system.

1) Speed of network is slow will be addressed by developing a stand-alone software to smooth all the transaction operations while processing the database administration. The stand-alone software does not need to load the Active Server Pages (ASP) pages. Just a click on execute file will only takes about five seconds to open the stand alone application compared to open the web browser to load the web pages.

2) When there is lacked of stock, no email triggering to notify the device owner to replenish the item. The developed software will be going to add the email triggering function to make the system more efficient. The super user will notify the stiffs or suppliers to replenish the items by sending email to them in order to make the system more systematic.

3) To reduce the items damaged components, the pogo pin counter due that has built in the tester interface units need to be kept track to ensure the items must undergo routine maintenance. All the items counter units, which more than 150000 units are not allowed checking out unless they have undergone the routine maintenance service. The system will auto keep track of the counter units which current system lack of this feature.

4) All the new items need to be labeling with the barcode items in order to smooth the transaction operations. Current system needs extra software to support barcode printing module. This has caused inefficiency of printing the barcode. The developed software suggested integrating the barcode printing portion with the software to make the printing portion more convenient and save time.

5) The transaction and inventory searching is not effective enough in the existing web-based system. Therefore, interactive graph will act as an indication of inventory status also suggested to include in the developed software.
6) The inventory and transaction operations report still have to do manually. The developed software is suggested to create the report wizard that will help the staff to generate out the transaction operations report and printed out. This report wizard certainly saves much time to do the report manually and becomes a paperless system.

All the expected output will address those issues effectively according to the system requirements and the project methodology.

1.7 Summary

Finally, the Spare Parts Inventory Management System (SIMS) software will be developed to replace the existing web-based application that is currently implementing at the Intel Corporation’s PG6 production floor to handle test hardware inventory.

The developed software will fulfill all the project objectives to ensure the project will definitely bring more benefits to improve the manufacturing productivity and realize the cost savings. The project scope for the developed software has been particularly reviewed and analyzed in order to meet the user requirements. There will be some extra features that might add into the developed software in order to address issue of inefficiencies caused by the existing SIMS web base application.

The developed software will be more effective in handling the test hardware inventory conveniently compared to the current system, as it will be developed according to the right project objective, scope and the significance that may have considerable impact in the development work.
CHAPTER II

LITERATURE REVIEW

2.1 Introduction

Thomas Bronack (2001) referred that an inventory is a stock or store of goods. Inventory Management is an enterprise-wide discipline concerned with the identification and tracking of Information Services (IS) hardware and software assets (Quoted from Inventory Management System journal, released date November 21, 2001).

Valogix, Inc. (2003) had foreseen that in today’s uncertain business climate, managers look for simple ways to reduce waste and improve profitability. New initiatives must be inexpensive, quick, and have a high return. Service parts inventory management is a prime candidate. With many parts to manage and a lack of power tools, most companies with parts inventories have too many of the wrong parts. The result is unnecessary inventory expense, while still suffering service-limiting stock-outs.

From the perspective of business capital, product inventory represents approximately one-third of business capital investment (Quoted from REM Associates Management Consultants Distributor Investment “Meeting the Challenge of The 90s” Purchasing and Inventory Management journal, 2002).
Figure 2.1: Statistic shows that the product inventory has 33% among business capital investment

The most progressive, competitive manufacturing organizations see management of production assets as a potential strategic advantage. They are developing integrated machinery management programs that pull all the separate technologies and management techniques together in a way that allows them to understand where the problems are and how important they are. Knowing that, they can make plans to solve those problems permanently. Until they know what the problems are, any action taken will at best result in short term solutions. In the worst case, it may make the problem worse (Fleischmann, 2001).

There are many current journals and some researches on the similar projects that have been reviewed. Through the survey, many authors have addressed inventory management in the context of product recovery and remanufacturing. This section will be going to summarize the main findings presented in the literature. The selected references highlight significant contributions but are not meant to be exclusive. The case study about inventory management system has been carried out on Exel Solstice House Inc. as the company has ever impressive and successful business management since implementing the CRC system fully integrated business inventory management system since 1990 from the source (http://www.exel.com).
2.2 Fact And Finding

This section will discuss about the Exel Solstice House inventory management system about the inventory and service levels, supply and demand, inventory and competitive advantage, common issues, Exel’s solution, customer benefits and approach.

2.2.1 Exel’s Inventory Management

The Exel Solstice House has an extremely systematic CRC inventory management system, as inventory is the key element of all supply chains. Through effective CRC inventory management system, inefficiencies can be driven out of the supply chain and overall costs reduced. Managing inventory levels across the supply chain is complex and affects all the other elements of the supply chain. A high level of inventory is not only capital intensive but also expensive to service through increased spend on capital, warehousing, transport, and procurement. Typical benefits that can be achieved through Exel’s inventory management methodology are:

1) Increased annual sales by over 500%
2) Realized annual cost savings of up to $300 000
3) Increased sales by 30%; decreased warehouse staff by 30%; reduced time spent invoicing by 75% (http://www.exel.com)

The Figure 2.2 showed the statistic of the annual sales, annual cost savings, sales, Exel has achieved warehouse staff and time spent on invoicing that throughout recent years after implementing the business inventory management. From the statistic’s comparison, it is obvious to notice that the Exel has gained the typical benefits due to the inventory management methodology.
2.2.2 Inventory And Service Levels

There is a direct correlation between service levels and the level of inventory held. Many companies hold high levels of inventory to ensure that service levels remain high. The higher the level of inventory the less chance of a ‘stock out’ and therefore caused a service failure. This tradeoff is called the inventory service balance. To ensure that the inventory always available for all, the develop software will have the trigger duration fix and after the trigger duration has reached, email will be triggered to the device owner to replenish the inventory.
2.2.3 Supply And Demand

An effective supply chain can be measured by its ability to match supply with demand. The most streamlined examples are those where products are built to order. However, this model is not applicable to most cases; therefore, it is necessary to find the optimal way of matching the expected demand for product, with the inbound supply of materials and components.

2.2.4 Inventory And Competitive Advantage

Through matching supply with demand, a supply chain becomes far more streamlined and responsive. Not only does this drive down costs through reduced inventory and overhead, it drives up product service through better availability and speed of response. All the product transactions will be recorded into the data manager and the users can search by transactions and inventories using the developed software.

2.2.5 Common Issues

Exel encountered some common issues:

1) Companies are frustrated in their efforts to improve availability and reduce inventory investment.

2) Expectations that a new computer system will deliver bottom line benefits have not been met.
3) Software or consulting alone will not manage inventory and deliver the benefits needed to remain competitive.

4) Management is no longer in control of the key drivers of their inventory – The Replenishment Process.

2.2.6 Exel’s Solution

A specialist inventory management methodology has been developed by Exel specifically to allow unparalleled control of inventory in the supply chain. This inventory management methodology is designed to focus on the immediate priorities to drive results in:

1) Supplier management
2) Expediting
3) Order replenishment
4) Demand forecasting
5) Safety stock setting
6) Order pipeline monitoring
7) Excess stock management

The Exel inventory management methodology works in a systematic manner to quickly analyze the current situation make the required changes to fulfill the chosen strategy and then maintain the chosen inventory strategy. The stages are as follows:

1) Full analysis to determine the causes of excessive inventory
2) Decide on the inventory strategy such as the service levels required
3) Implement changes at line item level in line with strategy
4) Work at improving forecasting – focusing on the most important first
5) Analyze, set, and maintain supplier lead times
6) Set order placement strategy
2.2.7 Customer Benefits

Exel’s inventory management methodology aims to reap the following benefits:

1) Improved customer satisfaction
2) Improved customer retention
3) Increased sales
4) Improved profitability
5) Improved return on investment
6) Improved competitive differentiation
7) Improved cash flow

2.3 Approach

Exel has a dedicated inventory team who work across many different businesses implementing and managing Exel’s inventory management methodology. Exel puts people at the center of its solutions and unlike consultants or IT suppliers, Exel works across the supply chain in a practical ongoing basis to drive continual improvement in inventory. Through working in partnership with clients and feeding into their ERP systems, Exel can deliver sustainable benefits and competitive advantage.

2.4 Conclusion

From the survey, the developed software will be based on the Exel’s approach methods to have a systematic and procedural inventory management system. Comparing with Intel Spare Parts Inventory Management System (SIMS)
web-based application that was implemented at the PG6 production floor, there have some comparisons between the SIMS web-based application and stand-alone software:

Table 2.1: Comparisons between SIMS web-based and software

<table>
<thead>
<tr>
<th>SIMS tool web-based</th>
<th>SIMS tool software</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not a stand-alone application.</td>
<td>Stand-alone application.</td>
</tr>
<tr>
<td>Need to open Internet Explorer to load ASP pages – slower (take 1 minute).</td>
<td>Just open the execute file to run software – faster (take 30 sec).</td>
</tr>
<tr>
<td>Limited user interface design.</td>
<td>Contain user-friendly interface design:</td>
</tr>
<tr>
<td>Function limited.</td>
<td>a) Easy-to-use function.</td>
</tr>
<tr>
<td>Not integrate with barcode printing.</td>
<td>b) More security.</td>
</tr>
<tr>
<td></td>
<td>More function such as graph, email trigger, pogo pin counter.</td>
</tr>
<tr>
<td></td>
<td>Integrate with barcode printing:</td>
</tr>
<tr>
<td></td>
<td>a) No need extra software to support.</td>
</tr>
<tr>
<td></td>
<td>b) Make printing job easier.</td>
</tr>
</tbody>
</table>

After the case study, the developed software will target to have the typical benefits that Intel Corporation can be achieved through the Spare Parts Inventory Management System (SIMS) methodology that can increase annual sales, realize annual cost savings and reduce inventory costs.
CHAPTER III

PROJECT PLANNING AND METHODOLOGY

3.1 Introduction

This chapter provides some guidance for effectively planning software systems development work. In some systems development communities, the plan is called a "software development plan." The project plan is a gauge used, in part, to think through what needs to be done, to estimate how much the effort may cost and to determine whether software systems development work is unfolding as it was envisioned.

Thus, project planning, like software systems development, is an exercise in change management. It provides a baseline cost and scheduling description of the development effort that is used throughout the software life cycle to provide a basis for monitoring and controlling work. It will also create an effective communication between the developer and users in order to obtain a better understanding of the objectives. By this way, the project planning also can eliminate or reduce uncertainty and improve efficiency of the operation.

To accomplish and implement the software system, there have seven work package are listed out to make the work successfully and systematic. They are:

1) Preliminary investigation: The software project will define the scope of the project and the perceived problems, opportunities and directives
that trigged the project. There must also establish the project plan in terms of scope, development strategy, schedule, resource requirements and budget.

2) Problem analysis: The software project needs to have some level of understanding of the current system to improve or enhances the current system to have more features.

3) Requirements analysis: The software system will always be evaluated on whether or not they fulfilled business objectives and requirements, regardless of how impressive or complex the technological solution might be.

4) Design: After the proposal has been approved, design phase will be start on the user interface, coding and other packages or classes to meet the user requirements.

5) Development and implementation: Development and implementation of the software system addresses data, process, and the interfaces primarily from the system builder perspective. So that, the production system can delivers into system testing.

6) System testing: The software system will undergo testing process to find the defects and the risks associated with release of a software system.

7) Troubleshooting and maintenance: The software system requires troubleshooting and maintenance to fix any errors, debug, defect, omissions or new requirements that may arise.

During the research review, there are no meaningful one-size-fits-all software development methods. The approach one takes to a very large project must include explicit forms of planning, coordination and control that would be out of place or even harmful in a small project. Methods used, then, depend on such conditions as system size, reliability and safety requirements, cost constraints, implementation schedule, and maintainability and expected system life span. Each different requirements affect the methods used, the tools required, the quality assurance functions, the personnel needed and the documentation required.
3.2 High Level Project Requirements

High level project requirement encompasses project facilities requirements, software requirements, and hardware requirements. The mentioned requirements will be discussed in details in the following sub sections.

3.2.1 Project Facilities Requirement

During the SIMS software development, the meeting room may be needed for meeting and discussion about the user requirements. In addition to that, the laser printer might also be required for printing documents such as test plan, feedback form, user manual and others.

3.2.2 Software Requirement

The software requirement included the operating system such as Microsoft Windows XP Professional Edition. The supporting software will be Microsoft Visual C++ 6.0, Microsoft Access 2000, Rational Rose 2000, and Microsoft Project 2000 for project management as well as Internet Explorer Browser 6.0.
### 3.2.3 Hardware Requirement

The recommended specification for developing software system, which is suitable with the system requirement and the project methodology as follow:

**Table 3.1: Hardware tools**

<table>
<thead>
<tr>
<th>System</th>
<th>Processor</th>
<th>Memory</th>
<th>Peripherals</th>
<th>Storage</th>
<th>Input Devices</th>
<th>Output Devices</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>At least Intel TM Pentium 100MHz</td>
<td>Cache Memory 512 Kilobyte</td>
<td>Sound Card 32 Bit</td>
<td>Hard Drive At least 2 Gigabyte or above</td>
<td>Keyboard 102-key Multimedia Keyboard</td>
<td>Display 14 inch Super VGA monitor</td>
<td>CPU Casing Mini Tower</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Random Access Memory (RAM) At least 32 Megabyte</td>
<td>Network Interface Card (NIC) Compatible with LAN Specification</td>
<td>Floppy Drive One 1.44 Megabyte 3.5 Floppy Drive</td>
<td>Mouse Standard 2 button Serial Mouse</td>
<td>Speakers Standard Speakers</td>
<td>Modem 33.3 Modem</td>
</tr>
</tbody>
</table>
3.3 System Development Approach

The System Development Life Cycle (SDLC) provides an overall framework for system development. There are many more concepts for help, including methodologies, models, tools and techniques which will be discussed in details.

3.3.1 Project Methodology

The Waterfall is the simplest model of the software development process to view its stages as successors to one another. The Waterfall model gives a high-level view of the software life cycle. This model is a tried and tested problem solving mechanism. Documentation is an integral part of the process. This model has various stages where the work of the each stage is “signed off” before proceeding to the next phase. The problem with this model is that it allows errors in the specification phase, which is more costly to correct at a later stage.
Figure 3.1: Waterfall Model

The software development proceeds in clearly defined and distinct stages. The first step is to develop a set of requirements for the system to be built, which is written down, evaluated and then approved. Next, assuming these requirements are fixed; complete specifications for the system are developed and are again reviewed and accepted.

Once specifications are complete, the next step is to design the whole system. The top-level design is developed and the problem is broken down. Each of the subcomponents is designed as well and the design is completed for all components of the system down to the stage where their coding is obvious. Once the design of all components have been reviewed and checked, coding begins and the whole system is coded according to the design. Once the system is coded, it is then tested, starting at the module level and moving up to system testing. Once testing is complete, the system is distributed and maintenance begins.
The model does allow some flexibility. For example, it should be possible to begin coding some sections of the program before completing the detailed design of everything else and it should be possible to begin module testing of components as they coded. However, the general view here is that each phase of development is completed before the next is begun. Spare Parts Inventory Management System (SIMS) Software development occurs in several phases.

3.3.1.1 Requirements Analysis

This project attempts to determine the user’s needs and to outline the proposed system from the requirements gathering at the system level for all aspects of the system. The software scope, initially established and refined during software project planning, this will define functional capabilities, performance, design constraints and system interfaces.

It provides the software designer with representation of information and function that can be translated to data, architectural and procedural design. The software will be developed accordingly to the users’ feedback on previously the implemented SIMS web-based application system. Models of the required information and control flow, operational behavior, and data content are created. Alternative solutions are analyzed and allocated to various software elements.

The developed software will be built with the intentions to improve the existing features of the current system and some of extra and useful features will be added into the software. The result is generally a user model and a prioritized list of features to be included in the proposed software.
3.3.1.2 Specification

This includes an annotated system model, complete user-interface designs and a prioritized list of the capabilities of the proposed software. The SIMS software would be stand-alone software with full screen main interface. This may enhance to be touch screen used in future plan.

All the user-interface designs will be easy to use and user friendly as main consideration to accommodate for all the level of users. The database administrator can do some operations such as add/ update/ delete all the important data. The developed software will consider the speed of processing data that should be as fast as possible in order to smooth the transaction operations more effectively and efficiently. The emphasis here is on what is to be built, not how it is to be done.

3.3.1.3 Design

Software design is translating the requirements into a representation of software that can be assessed for quality before coding begins. According to (Pressman Publications, 2000), there are two phases of software design:

1) Preliminary Design (transforms requirements into architecture)
2) Detailed Design (refines the product of preliminary design into detailed data structures and algorithmic representations)

The software will work to handle all the transaction-captured records in order to manage the test hardware inventory management. The transaction and inventory search is considerably designed to locate where, identify who and when the product being check out, check in, routine maintenance and repair.
The barcode printing portion will be integrated into the software instead of using other software to support the printing job. Interactive designed of the graph bar chart function will be included to display the product inventory status. This involves both top-level design, where the overall framework for the system is constructed and detailed design, where individual packages are specified.

3.3.1.4 Coding

The detailed design is translated into code in the appropriate target language. The developed software will be using Visual C++® 6 integrated development environment (part of the Microsoft Visual Studio® 6 suite of development tools) and programming with Microsoft Foundation Classes (MFC). Visual C++ enables the developer to create Windows programs that have graphical elements such as buttons, menus and others that form a Graphical User Interface (GUI). MFC is a class hierarchy a developer can use to build Windows application quickly and easily. This should be the easiest phase of software development.

3.3.1.5 Testing

The code must then be tested. This is done at various levels, starting with module testing to check individual packages or classes, moving up to integration testing as the different packages are put together and finally ending with system and acceptance testing in which the system is tested as a whole. The Visual C++ Integrated Development Environment (IDE) provides a debugger tool to help the developer find run-time logic errors in programs that compile and link successfully but do not produce expected results. The debugger lets the developer view the
executing program and its data as the developer runs either one-step at a time or at full speed. The program stops on a selected line of codes or upon a fatal run-time error.

When the developer does not understand how the program produces incorrect results, running the program one statement at a time and monitoring the intermediate results can help the developer isolate the cause of the error. The developer can correct the code. This is how the Visual C++ provides the debugger for the developer to test the line of code by individual packages or classes.

3.3.1.6 Operation And Maintenance

The system is used, bugs are fixed and changes are made to accommodate new user demands or a changing environment. Maintenance is making adaptation of the software for external changes (requirements changes or enhancements) and internal changes (fixing bugs). When changes are made during the maintenance phase all preceding steps of the model must be revisited. According to (Pressman Publications, 2000), there are three types of maintenance:

1) Corrective (Fixing bugs/ errors)
2) Adaptive (Updates due to environment changes)
3) Perfect (Enhancements, requirements changes)

The SIMS simulation system will be delivered as testing software tools to the target users to test the system maybe for some period. The barcode printing portion will connect to the barcode printer at the production floor. The maintenance will be adapted to the barcode printer. Email triggering also will be maintained to support the Intel Microsoft Outlook. At the same time, the users’ feedback will be collected.
Based on the feedback, the modification of the system will be applied accordingly. The testing and modification process will be repeating until the better feedback has been collected. When the system has been implemented, the developer must maintain the system if there is any bugs to be fixed to ensure that the system is free of any bugs. In a successful system, this phase is typically the longest and most costly, often accounting for 80% or more of the overall software cost. These phases can be organized in various ways. Ideally, they will occur one after another, each one finishing before the next one starts. In practice, the knowledge gained in each phase makes one-change decisions made in the previous stage.

The requirements gathering at the system level for all aspects of the system has been analyzed to meet the project’s scope and objective. All the activities that will be carried out including the system development design, input design, output design, database design and interface design. The object-oriented software development will be designed using Unified Modeling Language (UML) technique. The software system will be using computer-aided software engineering (CASE) tool, which is considered appropriate software development tool for all products and environments.

3.3.2 Reason Of Chosen Methodology

The Waterfall Software Development Model has been applied on the Spare Parts Inventory Management System as the methodology, which is a systematic sequential approach to the software development that was modeled after a conventional engineering cycle.

The Waterfall model is the most mainstream and structured of the life cycle models. For this reason, this method will be used in project such as inventory
management system as the system will be rewriting programs to work in new environments. The model will be appropriate as well for the programs with strong mathematical or analytical traits so that it is easy to specify the requirements.

This should be used when the user knew exactly what they want the product to be. For example, the applications like an inventory management application that tells quantity stock and date. This model shows little opportunity for user feedback at the various stages of development until the very end. This will cause a situation where such little feedback is adequate for the Intel Corporation's own internal software.

When there is a need to get something such as data or information quickly and the specifications for the project are well documented such as programming for an automated system inventory management. The Waterfall model will be reengineering of the current software such as total rewriting of current software due to anticipated problems. A more robust model used for medium-sized projects. The requirements and specifications must be extremely obvious in black and white with no ambiguity.

The Waterfall model would best be implemented for projects on small systems, like perhaps the overall inventory management software system for the Intel manufacturing production floor at PG6 which comprising anywhere of 300 to 500 people. This is because this method breaks the project into phases of smaller parts and each phase must be completed before another commences. This slower approach works best with businesses that do not have to have the completed project the day after tomorrow.

The model would be most useful in projects with minimal user involvement or projects with flexible specifications that are left to the code developments. It allows them to solidify the requirements early in the life cycle and continue without
intrusions. The motivation for choosing them is that they require well-structure needs. The developed software would lend itself to the Waterfall model because it is useful to start with the set of basic requirements and create the program to manage the most basic transactions such as check out, check in, routine maintenance and repair. Once this is accomplished, a new set of changed requirements can be made and the more advanced transactions can then be handled. This can go on for a long-term enhancement.

The model is great for the developed software where the requirements are well defined and clear. Thus, there will not have much modification, as it is systematic to change the product. Software application, feedback is needed, because as the application grows, it must be verified and tested at each step, making sure it meets the specifications. Feedback loops enable developers to make modifications when needed.

This classic model is useful for internal developed software because sometimes the product can be different from what the user expects. Thus, internal software in which the user and developer are within the same company (internships at Intel for about four months) has a better chance of being correct because of improved communication. Developer will always communicate with the users in order to ensure product meets client's needs effectively.

3.3.3 Unified Modeling Language Method

The Spare Parts Inventory Management System (SIMS) software will be developing using object-oriented techniques. Unified Modeling Language (UML) has been applied on the developed software, as it has become the object-oriented modeling notation. The object-oriented technique provides the systematic activities
that lead from analysis to implementation in the Software Development Life Cycle phases.

The object-oriented technique also provides a set of graphic notations for use in reviews, inspections and documentation. There are five separate, but interrelated, object-oriented models or diagrams are used to define the application requirements from the object-oriented perspective. The five diagrams are:

1) The class diagram – identifies and classifies the objects that will make up the inventory management system. In a class diagram, the properties or attributes of each object that need to be recorded are also identified. It will show all classes and relationships for the entire system.

2) The use case diagram – identifies how the inventory management system will be used. A use case diagram is a convenient way to document the functions that the system must support.

3) The collaboration diagram – identifies all the objects involved to carry out a given business function. It also identifies these objects and shows the interactions or messages that are sent between them to carry out this function.

4) The sequence diagram – graphical view that emphasizes the sequence of the messages rather than the collaborating objects.

5) The state chart diagram – describes the states and the behavior of each individual object.

In addition, the object-oriented technique provides communication media between developers and users, a framework for modeling the domain problem and standards for transitioning the problem from analysis to final deliverable products to improve the system quality. Therefore, the object-oriented technique selection will have an impact on almost every step in the software development.
The computer-aided software engineering (CASE) has become software development tools for SIMS to create the interrelated object-oriented models or diagrams using Rational Rose 2000 as it provides direct support of the graphics and rules of the technique. It is a learning aid for the developer to concentrate on the analysis and design of the system and not on the mechanics and diagramming of the object-oriented technique. The CASE tool can adequately implement the chosen UML technique.

The CASE tool can enhance productivity and rigorous adherence to the method. It also supports adherence to the method. The CASE tool has the accurately supports notation since a simple drawing package is often sufficient for small projects. Besides that, the tool also has the consistency checking especially for large projects and has multiple data dictionaries support the object-oriented principle of information hiding. In addition to that, automated documentation generators often produce documents with poor visual quality.

3.4 Project Schedule And Milestones

Project schedule and milestones consists of project planning, project activities, and milestones of SIMS development. All these will discuss in the following sub sections.
3.4.1 Project Planning

The project planning for the Final Year Project started in 29 March 2004 and will be ending in 23 October 2004 for the semester 2004/05. The project has been carrying out according to the fixed timeline in order to have the project presentation at the final stage. All the project activities will be presented in the Gantt chart.

The primary objectives of the planning phase are to identify the scope of the system, ensure that the project is feasible, develop a schedule, allocate resources and budget for the remainder of the project. Project planning actually is an ongoing activity that documents, manages the use of, and improves an organization has chosen methodology for system development.

The mentioned seven work packages to make sure the work is systematic and efficient are preliminary investigation, problem analysis, requirements analysis, design, development and implementation, system testing and troubleshooting and maintenance.

3.4.1.1 Preliminary Investigation

Preliminary investigation is the first work package for a project. It must define the scope of the project and the perceived problems, opportunities and directives that triggered the project. It must also establish the project plan in term of scope, development strategy, schedule, resource requirements and budget.
The preliminary investigation is intended to be quick and should not exceed two or three days for the developed project. The preliminary investigation typically includes the following activities:

1) List the problems, opportunities and directives.
2) Negotiate the scope
3) Plan the project

The final deliverable for the preliminary investigation phase is completion of the project charter, which is usually a document. A project charter defines the project scope, plan, methodology, standards and so on. Project charter also define the project in term of participants, problems, opportunities and directives, statement of work to become completed, schedule and budget. The developer in the preliminary investigation might decide the project can continuous to proceed or terminated.

3.4.1.2 Problem Analysis

Problem Analysis work package describes with the statement “Don’t try to fix it unless you understand it”. There is always a current or existing system, regardless of the degree to which it is automated with information technology such as the inventory management system. There provide the analyst with a more thorough understanding of the problems, opportunities and directives that triggered the project.

Problem analysis is needed because developer for the project always need some level of understanding of the current system. If the project was triggered by a directive (such as compliance with a governmental directive and deadline) may initial a strategic or tactical plan or a project, there may be reasons to accelerate the problems in analysis phase.
The goal of the problem analysis is to study and understand the problem domain well enough to thoroughly analyze its problem, opportunities and constraints. Primarily, the problem analysis concerned with system owners and user view of the existing system. Based on the collected feedback from the users, the developed software system will be solving those frequent occurred problems.

Depending on the size of the system and its complexity, the illustrated work package may consume two or three days and can be accelerated by join requirements planning (JRP)-like sessions. The problem analysis typically includes the following activities:

1) Study the problem domain
2) Analyze problems and opportunities
3) Analyze business processes
4) Update the project plan

The final deliverable and milestone of this phase is to produce system improvement objectives that address problems, opportunities and directives.

3.4.1.3 Requirements Analysis

The requirements analysis defines the business requirements for a new system. Developers are frequently so preoccupied with the technical solution that they in adequately define the business requirements for that solution.

This phase is very important because it is critical to the success of any new information system. New systems will always be evaluated on whether or not they fulfilled business objectives and requirements, regardless of how impressive or
complex the technological solution might be. The developed software system will be ensuring to fulfill the business objectives, requirements and rules.

In this phase, a system model is drawn to document the requirements for a new and improved system. Alternatively, prototypes could be built to discover requirements. The requirements analysis typically includes the following activities:

1) Define requirements
2) Analyze functional requirements
3) Trace and complete requirements
4) Prioritize requirements
5) Update the project plan

The final deliverable and milestone for requirements analysis is to produce a business requirements statement that will fulfill the system improvement objectives identified in the problem analysis.

3.4.1.4 Design

After the proposal is approved, design phase will be started. The goal of the design is twofold. There are:

1) Developer seeks to design a system that both fulfills requirements and will be friendly to its end users. Human engineering will play a pivotal role during design.

2) Developer seeks to present clear and complete specifications to the computer programmers and technicians.
The approved design specifications will trigger the development and implementation phase. The design phase typically includes the following activities:

1) Design the application architecture
2) Design the system interface
3) Package design specification Update the project plan
4) Update the project plan

3.4.1.5 Development And Implementation

Development is the construction and installation of the system components. Implementation is the delivery of the system into production. Development and implementation addresses data, process, and the interfaces primarily from the system builder perspective.

The purpose of the development is to develop and test a functional system that fulfills business and design requirements and to implement the interfaces between the new system and existing production systems. So that, the production system can delivers into system testing.

The development and implementation typically includes the following activities:

1) Install and test new software package
2) Develop system and coding
3) Test system
4) Train users
3.4.1.6 System Testing

System testing is an activity aimed at evaluating an attribute or capability of a program or system and determining that it meets the required result. Process testing is done to find the defect and the risk associated with release of a software system.

The inventory management system has undergone testing for almost as long as software has been developed. When the software development process has matured, the approach to testing also evolved with formal testing methods and techniques being adopted by testing professionals.

Developer will involve in this phase to manage or mitigate the risk of failure of the system and the undesirable effects. Developer needs to identify areas of high risk that need to test thoroughly and to ensure the threat will not occur during operation of system by the user.

The approved system testing will trigger the troubleshooting and maintenance phase. The system testing typically includes the following activities:

1) Unit testing
2) Module testing
3) User acceptance test
4) Operations acceptance test
3.4.1.7 Troubleshooting And Maintenance

Troubleshooting and maintenance required to fix any errors, debug, defect, omissions or handling new requirements that may arise. Regardless of how well designed, constructed and tested a system may be, errors bugs will still inevitably occur. Bugs can be caused by poorly validated requirements, incorrectly implemented requirements or designs, misinterpreted requirements and so on.

The objectives of troubleshooting and maintenance are to make predictable changes to existing programs correct errors that were made during systems design and implementation and to avoid as much as possible degradation of system performance. The troubleshooting and maintenance typically includes the following activities to achieve the objectives:

1) Validate the problem
2) Benchmark program
3) Study and debug the program
4) Test the program

3.4.2 Project Activities

The developed software system is composed from a number of interrelated activities. The project activities for the software development of Spare Parts Inventory Management System (SIMS); consist of seven work packages, which are:

1. Preliminary Investigation
   1.1. List problems, opportunities and directives
   1.2. Negotiate scope
   1.3. Plan the project
2. Problem Analysis
2.1. Study the problem domain
2.2. Analyze problems and opportunities
2.3. Analyze business processes
2.4. Update the project plan

3. Requirement Analysis
3.1. Define requirements
3.2. Analyze functional requirements
3.3. Trace and complete requirements
3.4. Prioritize requirements
3.5. Update the project plan

4. Design
4.1. Design the application architecture
4.2. Design the system interface
4.3. Package design specification
4.4. Update the project plan

5. Development and Implementation
5.1. Install and test new software package
5.2. Develop system and coding
5.3. Test system
5.4. Train users

6. System Testing
6.1. Unit testing
6.2. Module testing
6.3. User acceptance testing
6.4. Operational acceptance testing

7. Troubleshooting and Maintenance
7.1. Validate the problem
7.2. Benchmark program
7.3. Study and debug the program
7.4. Test the program

Gantt charts are used in tracking a project's progress. It shows either a pictorial or a tabular representation of where in the project's life the effort is. It
shows completed task as well as milestones. It shows what has been completed and what is left to be done in the projects life cycle. Please refer SIMS Tools Gantt Chart in Appendix A.

3.5 Conclusion

Finally, the developer can use the project planning strategy and method to follow up the system development work. To accomplish the development work effectively, the developer needs to follow the seven-work package to carry out all the activities planning which are preliminary investigation, problem analysis, requirements analysis, design, development and implementation, system testing, troubleshooting and maintenance.

The developed software will apply the Waterfall model, which has six phases such as requirements analysis, specifications, design, coding, testing, operation and maintenance.

The developed software will be designed using Unified Modeling Language (UML) technique in order to make up the system using interrelated models or diagrams. The software system will be using computer-aided software engineering (CASE) tool that support the object-oriented technique to meet the project requirements.

The hardware and software requirements must be taken note in order to meet the system and user requirements. All the hardware and software requirements must be well documented to avoid any unexpected error or problems might occur to
corrupt the system. Any issues need to be addressed thoroughly to solve the inefficiencies of the implementation system.
CHAPTER IV

ANALYSIS

4.1 Introduction

Spare Parts Inventory Management System (SIMS) is the critical business challenge of getting the right part, to the right place, at the right time to deliver superior product inventory stock check service and improve the productivity expectations.

Industry leading companies like Intel, Dell and Toshiba Medical have recognized the strategic importance of superior service parts management and are using it to improve profits and drive customer loyalty to new levels. These leaders are eliminating decades of service parts inefficiencies with a consolidated service parts management solution that delivers immediate value through complete inventory control and sustainable longer-term gains in capital efficiency, customer satisfaction and profitability.

Today's capital markets demand rapid improvements to companies' top and bottom lines. That is why leading, global companies have identified spare parts management as an untapped opportunity to rapidly reduce costs and increase revenues while improving service levels. By focusing on what many companies are ignoring, these leaders are driving customer loyalty and profitability to new levels; all while gaining significant competitive advantages. With the help of automated
Spare Parts Inventory Management System, these leaders have achieved significant results:

1) Improved spare part availability by 10-20%
2) Reduced part inventory costs by 20-60%
3) Increased service revenue by 20-40%
4) Increased productivity by 50-100%
5) Improved customer loyalty by 7-10%

Spare Parts Inventory Management System (SIMS) tool web-based application for Tester Interface Units (TIU) tracking system has been implemented in the Intel Corporation’s PG6 manufacturing production floor to handle test hardware inventory. Therefore, the analysis business review will be surveyed on the existing system to obtain more information and studied case review about the user requirements and user-oriented documentation.

The analysis review documentation will describe the system’s purpose, the developers’ understanding of the problem domain and the solution addressing the problems through analysis of the system. The development of knowledge bases can go beyond finding defects and provide information to developers. As a result of that, it will increase developer quality to produce fewer defects in order to improve the quality of system.

4.2 Analysis Of Current System

Analysis of current SIMS Tool is studying the Intel Corporation manufacturing production floor system. Currently, the production floor has encountered some issues and problems. The problems will be analyzed and stated in the sub sections of this section.
4.2.1 Business Process

The Intel Corporation is the largest chipsets manufacturing to support all the personal computer motherboard. The revenue has been increasing by leap and bound. The following section will discuss about Intel Malaysia history and activities.

4.2.1.1 Intel Malaysia

Intel® Malaysia was among the first U.S. companies to begin operations in Penang Island in 1972, with an initial investment of US$2 million and staff of 100 people. Since then, Intel has played a key role in establishing Malaysia as a Center for High Technology Manufacturing, opening an office in Kuala Lumpur in 1995 to build on the excellent performance of the Penang factories and employees. Intel was also the first to begin operations at the new high-tech park in Kulim in 1996. Intel Penang located at Bayan Lepas Free Industrial Trade Zone (also known as Intel Technology and Intel Microelectronics), Intel Kulim located in Kulim, Kedah and Intel MSC located in Cyberjaya.

Intel has grown by leaps and bounds with investments of more than US $2.2 billion to date in Malaysia and has trained and employed thousands of talented locals. Today, with highly skilled workforce close to 8000 people located at three campuses, Intel Malaysia is one of Intel Corporation’s largest and most advanced manufacturing sites, building flagship products such as Pentium 4 processors as well as chipsets, network processors, micro controllers and motherboards.
Today, in addition to the assembly and test of Intel has most advanced microprocessors; Intel in Malaysia has also had the following capabilities such as Design, Marketing, Package Technology Development, Test Tooling Technology Department, Failure Analysis, Device Physics and Materials, Fundamental and Post Sales Support. United of States chip giant Intel is to invest 152 million ringgit (US$40m) to boost its manufacturing capacity in Malaysia.

Intel Technology Sdn Bhd (Intel Penang) is a test and assembly site in Penang and Kulim Hi Tech Park. Intel is considered one of the pioneers to set up office in Penang’s industrial history. Today Intel Penang tests and assembles Intel’s most advanced microprocessors and builds computer and networking/communications boards, it also has a design center, packaging technology development center, and embedded micro controller division sales and marketing.

The analysis business review has elucidated and reveals that Intel Corporation’s main business in the 1990s was in developing microprocessors for desktop computers and now even better poised to achieve a better match with high-growth opportunities in other parts of the computing industry, especially servers and networking and communications products, including wireless technologies.

4.2.2 Problem Analysis

In this section, activities are conducted for gathering information about problems faced and requirements needed by the users. All this information is important to implement the SIMS project. Thus, this section will briefly discuss about the current situation of existent SIMS Tools, activities conducted during analysis and the result.
4.2.2.1 SIMS Tools Analysis

SIMS is a web portal that contains three systems: Spare part management system, TIU tracking system and Standard Units tracking system. The TIU tracking system captures all transactions made when using TIU including Check In, Check Out, RM (Routine Maintenance) and Repair. Users of this system are able to easily keep track of the current location of TIU.

The Standard Units tracking system captures transactions made on Standard Units and Backup Units. The system triggers email to device owner when Standard Units’ trigger limit is reached. Device owners replenish standard units by checking out backup units. The system also triggers email to device owner when backup units’ trigger limit is reached. Device owners are responsible to replenish backup units.

The SIMS Tools was implemented in order to automate the TIU/Standard Units tracking process. The main objective of the SIMS Tools implementation is to set up one TIU central location with Personal Computer database to manage issuing, returning, maintaining and close monitoring of all the TIU.

Actually the SIMS tools is to prevent unnecessary down time when TIU/Standard Units not available. Therefore, the system will automatically report to personnel in charge when Standard Units’ trigger limit is reached.
4.2.2.2 Problem Details

According to the Intel Corporation NCO automation group leader (Pamela Tung An An) who had developed Spare Parts Inventory Management System (SIMS) Tools, the core objective of SIMS Tools is to automate the Tester Interface Units (TIU) tracking process in order to ensure the TIU handling process in control, no damage to components, cost saving and reduce unnecessary downtime as well as man hour to repair.

Before the SIMS Tools implementation, the manufacturing production floor always encountered issues of TIU missing due to mishandling as the entire TIU are handling manually that caused many cases of damaged components affecting machinery downtime. The cases had increased the expense in purchasing unnecessary and extra TIU to solve lack of stock inventory problems.

The user questionnaire was constructed to help identify existing SIMS Tools usage problems at NCO manufacturing production floor. The questionnaire had been handed out to PG6 manufacturing production floor Manpower Staffing Services (MS) without a usability expert being involved. Intel Corporation employers can utilize the questionnaire to determine existing SIMS Tools usage problems at computerized PG6 production floor. The analysis of results of the user inquiry is done in a way that guarantees the anonymity of users. The results immediately reveal troublesome cases of SIMS Tools web-based application use and may initiate further investigations on site.
Figure 4.1: SIMS Tools web-based problems analysis

The survey has been carried out on the functionality and usability of SIMS Tools operational. The SIMS Tools has been implemented primarily to address Tester Interface Units (TIU) break down or loss that might potentially cause the line down. Actually, the TIU serves as an interface between tester and units being tested which has become the most important feature of tester. The shortage of Standard Units when needed will also reduce the productivity. Therefore, there is a need to have systems to keep track of TIU and Standard Units.

During the survey analysis, SIMS web-based application performed quite slow loading the Active Server Pages (ASP) to display the content. Through the impressive inspection, the speed of network is slow at the production floor stands for 15% according to the questionnaire, which estimated around 5 Megabyte per second (Mbps). Generally, the speed of network at the production floor should be as fast as office used which estimated around two Mbps. If every transaction operation can be completed, as less megabytes as it gets, there will be no queue up situation occurred that caused the control central to be congested. Besides that, slower network speed
for server connection will be the root of processing job that become tedious and monotonous.

As a result of that, the SIMS web-based application can be concluded that it is not a stand-alone software application. The web-based application needs to connect to the Microsoft Internet Information Services (IIS) act as server using ASP server side scripting. Therefore, the application is slow to load the ASP pages to run the transaction operations. The low speed of network at the production floor certainly becomes the issue inefficiency of processing the transaction operations. It is advisable to setup a stand alone software application to address the low speed of network that exist at the production floor to smooth up the transaction operations in order to improve productivity.

Every tester owner needs withdraw TIU to test and setup the tester machine for chipsets manufactured. However, some tester owners will keep the TIU without return to the cabinets or just leave the units all over the production floor. The TIU would not have any proper keep track and there is no email triggering to notify staf fs or suppliers to replenish the items which estimated 15% among often occurrence problems in the current system. In other words, the system does not send any notification to the device owner to take care of the units and return to the cabinets when finished testing or setup.

Every TIU needs to have proper services such as routine maintenance and repair before keeping the units into the cabinets. If the units always have proper maintenance services, this will definitely realize cost savings and reduce damaged components. According to the survey, there will be issue lack of stock when the device owner does not replenish the items when the triggered duration has reached when the stock inventory has been checked. The lack of stock will certainly affect the productivity and the cost savings.
Each and every TIU has been attached with the pogo pin counter. The counter will record how many times or units that the device has been tested before. The maintenance services duration will also depend on the units to be practiced on them consequently. The standard TIU service units will be 150000 units. TIU will perform and operate the machine testing work if the units below 150000 units.

However, the TIU will be damaged or under repair when the service units beyond 150000 units. From the intellectual inspection, the current system does not include auto keep track pogo pin counter due feature. The lack of auto keep track pogo pin counter has contributed 21% spectacularly among the problems percentage. There is a need to add auto keep track of pogo pin counter due feature in order to ensure the TIU has been experienced routine maintenance once beyond 150000 units.

When the pogo pin counter due has reached or beyond 150000 units, it indicates that the specific item needs to change the pogo pin. If the pogo pin counter due has more than 150000 units without any knowledge, the items will easily encounter components damaged issue. Damaged components will definitely cause the machine down and affect the productivity as well. The TIU components are very expensive as one TIU costs amount of money around RM38000. Currently Intel Corporation manufacturing production floor cater about 300 pieces of TIU inventory. Any damaged components might compel Intel Corporation to purchase new pricey TIU that certainly cannot realize cost savings campaign.

Before the SIMS implementation, each and every TIU units there was no real time monitoring capability and the Manpower Staffing Services (MS) had to keep track TIU inventory manually. It took extremely much time-consuming for one MS to check 300 of TIU units to be validated everyday. The develop software will capture complete TIU transaction history that able to auto keep track of TIU inventory. Therefore, it is easy to locate TIU and Standard Units and can ensure TIU and Standard Units in tiptop condition.
However, the existing system does not have interactive graph that might assist in overall capturing TIU transaction operation. It made capturing TIU transaction history job more complex and inconvenient to search by inventory. In addition to that, the TIU transaction capturing cannot provide the fastest and instant information for the users as the system lack of interactive graph that will always displaying all the transaction status and inventory for the TIU. The lack of interactive graph issue has taken problem percentage about 15% based on the questionnaire analysis result.

When the new items have been transferred into the production floor, all the TIU will be labeling with the barcode sticker as their unique product name. The barcode labeling on TIU according to the unique product naming method has made the transaction operations more effective. According to the survey, the barcode printing portion is not integrated into the web-based application. The Super user will have to save a text file generated by the application on the local machine and use a printing program (written in Visual Basic) to print the labels out. The vendors provided the format of the labels to print out.

The printing barcode function needs additional software to support. This has cause inefficiency of printing the barcode using separated software to support. This has contributed about 21% enormously percentage among the occurrence problems.

4.2.3 Problem Statements

The Spare Part Inventory Management (SIMS) has been implemented to manage the entire test hardware inventory in order to smooth chipsets manufacturing operational. However, there are some issues or problems occurred before and during the implementation at Intel Corporation manufacturing production floor:
Before SIMS Tools implementation:

1) TIU missing due to misplace. One TIU costs around RM 38000 and Intel Corporation has estimated 300 TIU.

2) TIU components damage or missing due to mishandling. TIU components are expensive and the damaged components will definitely affect productivity due to down time.

3) There was no real time monitoring capability. No auto keep track of TIU causes TIU could not have proper repair.

4) Before SIMS Tools implementation, there was manual TIU inventory tracking.

After SIMS Tools implementation, some concluded problems have been listed out during the survey on the existing system:

1) Speed of network at the production floor is slow. It affected SIMS Tools web-based application performance and loading speed.

2) No email triggering to notify staffs or suppliers to replenish the items. This caused lack of stock inventory issue occurred.

3) No auto keep track of pogo pin counter due feature that caused more damaged components of TIU.

4) Barcode printing portion was not integrated into the existing system. It needed additional software to support the printing portion caused printing job ineffective and inconvenient.

5) No interactive graph as an indication about the summary of the product transaction operations and inventory.

After the SIMS Tools had been implemented for 11 weeks, the feedback list had been collected:
<table>
<thead>
<tr>
<th>Feedback</th>
<th>Owner</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Different PG belonging issue.</td>
<td>CHGan</td>
<td>Shut</td>
</tr>
<tr>
<td>WWID issue.</td>
<td>CHGan</td>
<td>Down</td>
</tr>
<tr>
<td>TIU ID issue.</td>
<td>CHGan</td>
<td>Shut</td>
</tr>
<tr>
<td>Run out of printer barcode roller.</td>
<td>CHGan</td>
<td>Down</td>
</tr>
<tr>
<td>PC broke down.</td>
<td>CHGan</td>
<td>Shut</td>
</tr>
<tr>
<td>Speed of network slow.</td>
<td>CHGan</td>
<td>Down</td>
</tr>
<tr>
<td>Login password issue.</td>
<td>CHGan</td>
<td>Shut</td>
</tr>
<tr>
<td>Barcode printer software debugs.</td>
<td>CHGan</td>
<td>Down</td>
</tr>
<tr>
<td>System ID issue.</td>
<td>CHGan</td>
<td></td>
</tr>
</tbody>
</table>

Figure 4.2: Feedback List

Once the problems have been declared, the user questionnaire survey showed that there are some excellent suggestions to enhance the existing system. Among the suggestions based on the analysis results are:

1) Improve database connection for information access (12%).
2) Integrate barcode printing with the software application to make the printing job more convenient and effective (25%).
3) Add the email triggering to notify the device owner (18%).
4) Add the interactive graph to provide instant inventory information (18%).
5) Add the auto keep track of pogo pin counter to reduce the damaged components for cost savings issue (24%).
4.3 Analysis Of To Be System

Analysis is done to determine the requirements in order to develop SIMS project. The analysis involved functional requirements, and technical requirements. The requirements analysis is a software engineering task that bridges the gap between system engineering and system design.

4.3.1 Functional Requirement

This section will explain the software functional and nonfunctional requirements that will be developed to fulfill the business rules.
The software functional of the developed system will locate information or related data from the systematic database effectively. Any transaction operation as well as inventory-searching module will display out related information to meet the user's prerequisite. User can obtain useful information from the system according to the appropriate software functional modules. When there are any database operations such as add, delete or update, the data will be brought up-to-date providing user the latest information.

There are five main modules in the SIMS Tools software application such as Transaction Module, Search Module, Super user Menu Module, Barcode Printing Module and Generate Report Module. The figure 4-5 showed the overall SIMS Tools specification of functional requirements.

The Manpower Staffing Services (MS) staff can select the transaction type and search for the product inventory. However, the super user can log on to access the Super user Menu to perform database administrator work such as update, delete and add operations. Besides that, the super user can also print barcode for the new product and trigger email when the trigger duration reached. The Use Case Diagram will specify the functional requirements more in details later in the Chapter 5.
Figure 4.4: Overall SIMS Tools specification of functional requirements

The software nonfunctional requirement of the developed system depends on the system reliability. The system will prompt out any meaningful message or warning to the user if any system error issues occurred. As a result of that, the database will always be updated and organized properly.

The Spare Part Inventory Management System (SIMS) Tools is a stand-alone software application that will be implemented to manage test hardware inventory for Tester Interface Units (TIU) tracking process. The developed software will enhance the existing system functionality in order to improve productivity and realize cost savings concept.

The crucial requirements that Intel Corporation demand are to ensure that the TIU handling process in control, smooth transaction operation and reduce unnecessary downtime at the manufacturing production floor. The user interface
design should be applied easy-to-use and user-friendly concept to meet all literate or illiterate users' level of computer knowledge. The target users actually will be entire Manpower Staffing Services (MS) who working at NCO manufacturing production floor. The survey will be carried out to MS using questionnaire method to find out the system requirement.

Actually, the existing SIMS Tools web-based application has played fundamental role to automated TIU tracking process and it did improve manual TIU inventory tracking process. Owing to that, the developed software will enhance entire features that exist in current system to be stand-alone software in order to have real time monitoring capability.

4.3.2 Technical Requirement

Technical requirements comprises of software, hardware, and implementation requirements. Technical requirements are the specifications that required by SIMS project.

4.3.2.1 Software Requirement

This section explains about the required software tools in developing the software system as well as the justifications of choosing them. The chosen software tools are according to the functionality and the suitability. The following are the fundamental software and software tools, which should be used for developing environment.
<table>
<thead>
<tr>
<th>Items</th>
<th>Software</th>
<th>Justification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Microsoft Access 2000</td>
<td>Microsoft’s software that build the database system to keep the inventory and users’ data. It is secure database that using the SQL queries operate some database administration work such as alter, delete tables and also add, delete and retrieve data (<a href="http://www.access-developers.co.uk/why-access.htm">http://www.access-developers.co.uk/why-access.htm</a>).</td>
</tr>
<tr>
<td></td>
<td>Rational Rose 2000</td>
<td>Software to create interrelated object-oriented models or diagram.</td>
</tr>
<tr>
<td></td>
<td>Internet Explorer Browser 6.0</td>
<td>Software that acts as web surfing tool to view the Internet or Intel’s Intranet data content in a stable and better way.</td>
</tr>
<tr>
<td>Programming Language</td>
<td>Microsoft Foundation Classes (MFC) program work under Microsoft Visual C++ 6.0.</td>
<td>Visual C++ enables the developer to create Windows programs that have graphical elements such as buttons, menus and others that form a graphical user interface (GUI). MFC is a class hierarchy a developer can use to build Windows application quickly and easily.</td>
</tr>
</tbody>
</table>
4.3.2.2 Hardware Requirements

The SIMS Tools software application needs to have proper setup using one Personal Computer with processor at least Intel™ Pentium 100MHz. It has become the core hardware to develop the software. Besides that, Random Access Memory (RAM) estimated at least 32 Megabyte to compile the program; hard disk at least 2 Gigabyte or above to store data; 14 inch Super VGA monitor is required to display the software interface as well as 102-key Multimedia Keyboard and Standard 2 button Serial Mouse act as input devices.

The developed software will connect to the laser printer to print barcode. Newer high-density printers allow for the printing of very small labels with high information density. The barcode scanner will be used to scan the generated barcode pattern with high speed scanning to display the product ID. SIMS software will scan the barcode ID based on each unique product ID for tracking purposes such as location and inventory.

4.3.2.3 Implementation Requirements

Spare part management system (SIMS) is stand-alone software that contains five modules for TIU tracking system, which are Transaction module, Searching module, Super user Menu module, Barcode Printing module as well as Generate Report module.

The TIU tracking system will capture transaction operations such as Check In, Check Out, RM (Routine Maintenance) and Repair. The system will be able to
keep track the current location of the TIU. In addition to that, the system will trigger email to device owner in order to replenish the items.

The automate SIMS Tools will have Searching module to inspect the TIU/Standard Units tracking process. Transaction and inventory searching module will provide close monitoring to all the TIU. Barcode Printing module will be labeling the entire new TIU in order to ensure that each and every TIU has unique product name. The SIMS Tools will scan the barcode sticker on each TIU for tracking purposes such as location and inventory.

When the completed SIMS Tools is going to be implemented at NCO manufacturing production floor to manage TIU tracking inventory, the system need to follow the setup operations consequently. First and foremost, SIMS Tools needs one Personal Computer, which must meet the hardware and software requirements. Next, the computer must connect to the printer for the purpose of barcode printing use.

After all the setup operation has been done, the administrator should organize the database management system to meet the system requirement.

1) Add new TIU into the system
   The super users will register new TIU, which contains information about TIU ID, Department, Building, Cabinet number and Equipment Type. Each and every TIU has unique TIU ID to ensure there will be no naming violation.

2) Print barcode for TIU
   Super users are able to select new TIU and print out the labels for TIU. Next, the entire new registered TIU will be labeled with the barcode generated by the application on the local machine. Therefore, the SIMS Tools will scan the TIU barcode ID for transaction and inventory purposes.
3) Edit or Delete TIU
Only super users are able to edit or delete TIU. Once TIU has been deleted, all the transaction associated with that TIU will also be deleted as well.

4) Transaction of TIU (Check out, Check in, RM and Repair)
The transactions process flow will be verified during the SIMS Tools implementation.

Figure 4.5: Process flow of TIU transaction for PG6

Each transaction is captured in details such as System number, Worldwide ID (WWID) or person who makes transactions, TIU ID, Transaction Type (Check Out, Check In, RM and Repair) and date of transaction. There is a checking process to make sure that transactions made are valid:
a) There is enough and valid information has been submitted.
b) Each and every TIU has to go through RM/ Repair before Check In.
c) The order of transactions has to comply with the above diagrams.

After the RM/ Repair procedure, users will need to fill in the
comments/ remarks on the status of the TIU such as reason of failure, what action had to take and others.

5) Search for transaction and inventory of TIU
The application assists users in keeping track of all the transactions. The search for transactions portion provides filters for users to search such as equipment type, date range, transaction type and building. A statistic report will be generated based on the searching criteria and users can export it to Excel for capturing important data use.

To operate the implementation plan successfully and effectively, the operations scope and requirements that might be needed has been well measured:

1) Hardware requirement – Personal Computer, Printer and Barcode Scanner.
2) Software Tools – SIMS Tools.
3) Scope – All TIU in NCO6 manufacturing production floor.
4) Resource – One TIU MS per Shift to support acts as super user.
5) Traceability – TIU ID, WWID and System ID.
6) TIU ID – Barcode label on each TIU.
7) Control Centre – Centralize TIU room at the production floor.
CHAPTER V

DESIGN

5.1 Introduction

This chapter will explain about the system design in more details which based on the object-oriented concept using UML method. There will be graphical depiction of object-oriented analysis and design models such as Use Cases, Class diagrams, Activity diagrams, Sequence diagrams and Collaboration diagrams. It will increase consistency among models developed for the reusability of analysis, design and programming results.

The software development design is fundamental to recognize the software quality so as to meet the user requirement properly. The developers need to distinguish the design which has been prepared according to the accurate objective, project scope and the approved user requirements in order to have well constructed of the software design. Design is a process which is characterized by creativity, complexity, compromise and choice.

The system design involves conceptual design and logical design for the SIMS Tools design activities. The conceptual of the system design will be demonstrated by the Use Case Diagram. However, the logical of the system design will be verified using the Sequential Diagram. Consequently, the Class Diagram and
the Package Diagram will elucidate more details about the physical of the system design.

In addition to that, the database design will also be clarified in this chapter. Input and output design will be identified for SIMS Tools system in order to provide the comprehensible overview about the functionality of the system. Finally, the interface design will be discussed to present the overall preview of the developed system.

5.2 Preliminary Design

Preliminary or high level design is describing about the early design of the SIMS Tools. It consists of raw data, system architecture, user interface design, and database design. The following sub sections will discuss in more details about the topics.

5.2.1 Raw Input

The pilot study was an opportunity to examine the usefulness of SIMS Tools application. A more extensive examination of reliability and validity of the survey were warranted, however, and this was conducted to the extent possible within the existing constraints of developed SIMS Tools project.
The primary goals of the pilot study are:

1) To examine issues around implementing and using the existing SIMS Tools web base application faced by a variety of Network and Communication Operations (NCO) manufacturing production floor staffs.

2) To identify and correct problems or gaps in the existing SIMS Tools definitions which might lead to inconsistencies in the data being collected.

With regard to the first goal, the survey has been carried out to place significant emphasis on the systematic collection of outcome data. Nonetheless, in collecting and maintaining outcome data, many staffs are faced with unfamiliar procedures and challenges such as obtaining the correct information from SIMS Tools, maintaining accurate databases, perform the transaction operations accordingly and so on. Thus, the pilot study was an attempt to gain a better understanding of these implementation issues and to provide suggestions regarding to how some of these challenges might be overcome.

Secondary goals of the pilot study were to collect and summarize information about the SIMS Tools developed software raw data variables as well as to define some of the potentially useful outcome variables which could be derived from SIMS Tools items. It is necessary that data elements can be clearly defined and well understood by the users.

This report contains summary raw data on a number of outcome variables based on the survey on the existing SIMS Tools web base application. The raw data variables are divided into four entities:

1) Product – The Product data structure maintains information about a specific business form. Products are distinguished by their unique Product ID’s.
   a) Product ID – capture unique product ID
b) Product Name – capture product name

c) Description – capture product information such as function

d) Duration – capture date to check in

e) Inventory – capture product availability

f) Pogo Pin Counter – capture pogo pin counter due

g) Supplier ID – capture supplier ID

2) Supplier – The Supplier data structure maintains information for a specific supplier. Suppliers are distinguished by their unique Supplier ID.

a) Supplier ID – capture unique supplier ID

b) Name – capture supplier name

c) Company – capture supplier company

d) Description – capture company information

e) Email – capture supplier’s email address

f) Hand phone – capture supplier contact number

g) Address – capture company address

3) Transaction – The Transaction data structure maintains information for all the history of product’s transaction operations, distinguished by its unique World Wide ID and Product ID.

a) World Wide ID – capture unique employee ID

b) Product ID – capture unique product ID

c) Check Out Date – capture check out date

d) Check In Date – capture check in date

e) Transaction – capture check out, check in, RM and repair

f) System Number – capture system number

g) Description – capture RM and repair description

4) User – The User data structure maintains information for being as normal user or super user status, distinguishable by its unique World Wide ID and has password protection.

a) World Wide ID – capture unique employee ID

b) Password – capture password login

c) Name – capture employee name

d) Status – capture normal user or super user status

e) Email – capture user’s email address
f) Department – capture department number

 g) Building – capture Intel Corporation building

 h) Hand phone – capture user contact number

The raw data variables that have been collected are very fundamental and important for SIMS Tools development work in order to meet the user requirements. These variables will be applied according to the Transaction Module, Search Module, Super user Menu Module, Barcode Printing Module and Generate Report Module consequently.

5.2.2 System Architecture

The SIMS Tools will be one centralized control at the NCO manufacturing production floor that manages the test hardware inventory. The centralized architecture is the most commonly used one and consists of a single SIMS controller responsible for the management of the whole system. The SIMS controller handles the communication with the staffs and the super users of the TIU inventory management system, provides centralized decision support and controls as well as maintains the inventory repository.

The centralized system offers the inventory management data processing, handling decision support, being concerned mainly with information gathering collection, provides key management services like monitoring and control, throughput calculation and so on. This architecture offers easier maintenance and expandability as well as simplifies development of integrated application. The centralized processing involves a mainframe and terminals located at one central location to provide information to entire Intel Corporation NCO manufacturing production floor.
The centralized SIMS Controller will control the five main modules in the SIMS Tools:

1) Transaction Module
2) Search Module
3) Super user Menu Module
4) Barcode Printing Module
5) Generate Report Module

The SIMS Tools system will support two types of users:

1) Staffs will use the system to:
   a) Perform the transaction operations using Transaction Module.
   b) Perform the searching operations by inventory or transaction using Search Module.

2) Super users who act as administrators will use the system to:
   a) Add a new product, update or delete an existing product. They will be able to add, update or delete the profiles of users such as staffs and super users or suppliers using Super user Menu Module.
   b) Select the new added product ID to generate and print out the barcode to label the new product using Barcode Printing Module.
   c) Generate transactions report using Generate Report Module.

The SIMS Tools system will also have the following automated email triggering and inventory control functionality:

1) The system will maintain a dynamic product list.
2) The system will maintain a dynamic list of records of the users such as staffs and super users as well as suppliers.
3) The system can send email for the appropriate supplier when product triggered duration has reached.
4) The system will automatically keep track of the pogo pin counter due when the TIU units more than 150000 units.

The system development process will be categorized according to the modules in order to have short time consuming during the SIMS Tools development.
and construct the uncomplicated software application. The figure 5-1 showed the system design for SIMS Tools software application.

![Diagram showing the SIMS Tools System Design]

**Figure 5.1: The SIMS Tools System Design**

### 5.2.2.1 Transaction Module

The Transaction Module will be developed to manage the transaction operations in order to store the transaction information into the database. The Transaction Module will perform basic Check In and Check Out of parts. Among the functions in the Transaction Module are:

1) Select transaction type such as Check Out, Check In, Routine Maintenance (RM) and Repair.

2) Auto keeps track of the pogo pin counter due. The system will verify whether the pogo pin has more than 150000 units.
3) The system will validate the transaction operation based on proper condition.

**5.2.2.2 Search Module**

The Search Module is to search information of parts. This module will be divided into two main areas for searching:

1) Search by transaction
   The users can gain the product information such as the required product has been checked out, checked in, RM and repaired.

2) Search by inventory
   The users can gain the product inventory information such as which product still available in the cabinets.

The users can specify the criteria to search for both areas to gain the information on demand. The SIMS Tools system will display out the search results in details to provide the users instant useful information.

**5.2.2.3 Super User Menu Module**

The Super user Menu Module is accessible only to super users. From there, the hierarchy structure for a part, department, module, equipment and adding of fellow super users may be maintained. The users must key in the correct password to log in to access the super user menu.
Under the Super user Menu Module, the main menu contains some database administration functions:

1) Add new TIU
   Users fill in all necessary information in order to add a new TIU into the system. Thus, the added information will be stored into the database for transaction and searching use.

2) Update or Delete TIU
   To make this function more effective, users will narrow down the scope by specifying the building and the equipment type. Consequently, the users will be able to update or delete the TIU.

3) Trigger email
   The super users are responsible to send the email to notify the device owner in order to replenish the items. Besides that, the super users can also choose to use the telephony function to contact the suppliers.

4) Displaying interactive inventory graph
   The super users can view the interactive graph bar charts that will always displaying all the transaction status for the TIU. It will definitely provide the fastest and instant information for the users.

5.2.2.4 Barcode Printing Module

First and foremost, the users must add the new TIU through the super user menu; next the users can select the added new TIU ID. The system will generate out the TIU ID as barcode pattern. The users can preview the generated barcode before print out. After printing out the barcode, it will be labeling on the new TIU for transaction operation use.
5.2.2.5 Generate Report Module

The super users can use the report wizard to generate out the transaction report to be printed out. The report will show all the transactions that were performed from a specific date range. All transactions whether it is a Check In, a Check Out, an Added new parts, a replenish part and so on are logged and can be viewed from the generated report.

5.2.3 User Interface Design

User interface design specification will describe what the software looks like to the user and how the user will interact with it. The user interface design can evaluate alternative approaches for flexibility and usability of the SIMS Tools system. From there, the developer can select the best approach with minimized cost and time constraints as well as maximized growth potential.

The SIMS Tools system should support the following functionalities:
1) user friendly and easy-to-use graphical user interface (GUI)
2) interactive inventory data input/output interface
3) inventory database management system
4) SIMS Tools screens will use buttons, menus and icons

The user interface design will consider the system and information server performance issue. The software application design will ensure such information should include service throughput (in service requests and bytes per second), error and timeout rates, service availability, server and system downtime, system resource utilization and others. The system has unique interfaces for staffs and super users who can use the system and what products are available. The database graphical user interface enables the users to access nearly every action that they performed.
That is the reason why the developed project will be enhanced to replace the existing SIMS web-based application. The main benefit of the SIMS Tools stand alone software design is to improve the speed of data retrieving and reduce the system downtime. The most important requirement of user interface design is to improve the inefficiency of existing web-based application during transaction operations and minimized time consuming of data processing. As a result of that, it can reduce network traffic so that the network load is reduced and response time is improved. The SIMS system will be less likely to experience a catastrophic failure.

The SIMS system contains five main modules which are Transaction Module, Search Module, Super user Menu Module, Barcode Printing Module and Generate Report Module. The following narrative describes the interface design for the five main modules.
5.2.3.1 Navigation Design

![Diagram of Spare Part Inventory Management System]

**Figure 5.2: Data flow diagram**

The interface flow of the system would be the staffs can interact with the Main Transaction Page that will handle all the transaction operations such as Check Out, Check In, Repair and RM (Routine Maintenance).

The Super User Menu Login Page will authorize the access of super user as SIMS administrator. If the staff login successfully, the Intro Page will display welcome to Super User Menu banner. The super user can add user, product and supplier profile using the Add Profile Page.

The Search Page enables super user to search by transaction and search by inventory with valid searching criteria. Besides that, the Data View Page will display searching result. To print out the barcode for added new product, the
Barcode Page will preview the generated barcode and the Data View Page will display the entire Product ID to be generated as barcode.

Moreover, the super user not only can use the Report Page in order to display the generated report but also can use the Report Wizard Page as a user guide to generate out the report. The super user can get instant information through the Graph Page that will display the generated graph. He can use the Graph Type Page to view the graph in line, column or line and column chart. Finally, the Browser Page will enable super user to browse Intranet and Internet.

5.2.3.2 Input Design

Information is transmitted as it flows through a computer based system. The system accepts input in a variety of forms; applies hardware, software and human elements to transform input into output; and procedures output in a variety forms. Controls necessary to manage and ensure the reliability and security of the inventory transaction activities.

The data in the SIMS Tools system takes the following form:
1) It resides in a database.
2) It is available to the users that are allowed to view it.
3) It can be added through friendly user interfaces.
4) It can be modified or removed if necessary.

Staffs are the SIMS Tools system users who will do the transaction operations and searching operations using Transaction Module. However, super users will login to manage the database management work such as add, update or delete products, users and suppliers profile; search by transaction or by inventory;
barcode printing as well as generate report. These involve Super user Menu Module, Search Module, Barcode Printing Module and Generate Report Module.

1) Transaction Module
The staffs will perform the transaction operations using the SIMS Tools software application.

<table>
<thead>
<tr>
<th>Transaction Module</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tool</td>
<td></td>
</tr>
<tr>
<td>Text box</td>
<td>World Wide ID</td>
</tr>
<tr>
<td>Text box</td>
<td>Product ID</td>
</tr>
<tr>
<td>Text box</td>
<td>Pogo Pin</td>
</tr>
<tr>
<td>Text box</td>
<td>System Number</td>
</tr>
<tr>
<td>Radio button</td>
<td>Check In, Check Out, RM or Repair</td>
</tr>
</tbody>
</table>

2) Search Module
The staffs can select appropriate search criteria to search for product inventory information.

<table>
<thead>
<tr>
<th>Search Module</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tool</td>
<td></td>
</tr>
<tr>
<td>Radio button</td>
<td>Transaction or Inventory</td>
</tr>
<tr>
<td>List box</td>
<td>Equipment</td>
</tr>
<tr>
<td>Date picker</td>
<td>Range of date</td>
</tr>
<tr>
<td>Text box</td>
<td>Product ID</td>
</tr>
<tr>
<td>Tree view</td>
<td>SIMS table data</td>
</tr>
</tbody>
</table>
3) Super User Menu Module
The super user must login to access the super user menu. The super user is responsible for all the administration work such as barcode printing and generates report.

Table 5.3: Super user menu module

<table>
<thead>
<tr>
<th>Tool</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text box</td>
<td>Login WWID</td>
</tr>
<tr>
<td>Text box</td>
<td>Login Password</td>
</tr>
<tr>
<td>Text box</td>
<td>Product ID</td>
</tr>
<tr>
<td>Text box</td>
<td>Product Name</td>
</tr>
<tr>
<td>Text box</td>
<td>Product Description</td>
</tr>
<tr>
<td>Text box</td>
<td>Product Duration</td>
</tr>
<tr>
<td>Text box</td>
<td>Product Pogo Pin Counter</td>
</tr>
<tr>
<td>Text box</td>
<td>Supplier ID</td>
</tr>
<tr>
<td>Text box</td>
<td>Supplier Name</td>
</tr>
<tr>
<td>Text box</td>
<td>Supplier Company</td>
</tr>
<tr>
<td>Text box</td>
<td>Supplier Description</td>
</tr>
<tr>
<td>Text box</td>
<td>Supplier Email</td>
</tr>
<tr>
<td>Text box</td>
<td>Supplier Hand phone</td>
</tr>
<tr>
<td>Text box</td>
<td>Supplier Address</td>
</tr>
<tr>
<td>Text box</td>
<td>User WWID</td>
</tr>
<tr>
<td>Text box</td>
<td>User Password</td>
</tr>
<tr>
<td>Text box</td>
<td>User Name</td>
</tr>
<tr>
<td>Combo box</td>
<td>User Status</td>
</tr>
<tr>
<td>Text box</td>
<td>User Email</td>
</tr>
<tr>
<td>Text box</td>
<td>User Department</td>
</tr>
<tr>
<td>Text box</td>
<td>User Building</td>
</tr>
<tr>
<td>Text box</td>
<td>User Hand phone</td>
</tr>
</tbody>
</table>

4) Barcode Printing Module
Once the super user has logged in to access Super user Menu, they can choose to print barcode.
Table 5.4: Barcode printing module

<table>
<thead>
<tr>
<th>Barcode Printing Module</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tool</td>
<td>Information</td>
</tr>
<tr>
<td>Text box</td>
<td>Product ID</td>
</tr>
</tbody>
</table>

5) Generate Report Module

Once the super user has logged in to access Super user Menu, they can choose to generate report.

Table 5.5: Generate report module

<table>
<thead>
<tr>
<th>Generate Report Module</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tool</td>
<td>Information</td>
</tr>
<tr>
<td>Text box</td>
<td>Report Criteria</td>
</tr>
</tbody>
</table>

5.2.3.3 Output Design

Based on the inputs data such as text, numbers, and selection box that the users entered to the form, the system will implement the information processing to transform inputs and data into output in order to manage information processing activities.
1) Transaction module

Table 5.6: Transaction module

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid World Wide ID, Product ID, Pogo Pin, System Number</td>
<td>Transaction is valid and the staff is represented with the transaction type options.</td>
</tr>
<tr>
<td>Valid Check In, Check Out, RM or Repair</td>
<td>Transaction is successful and the staff is represented with transaction operations summary.</td>
</tr>
<tr>
<td>Invalid World Wide ID, Product ID, Pogo Pin, System Number</td>
<td>Transaction is invalid when the pogo pin is more than 150000 units and a warning message will be prompted out for changing pogo pin.</td>
</tr>
<tr>
<td>Invalid Check In, Check Out, RM or Repair</td>
<td>Transaction is not successful when the staff selected wrong transaction type.</td>
</tr>
</tbody>
</table>

2) Search module

Table 5.7: Search module

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transaction or Inventory</td>
<td>The product transactions or product inventories will be displayed according to the searching criteria.</td>
</tr>
<tr>
<td>Equipment</td>
<td>The search result will list out the entire equipments that the staff required.</td>
</tr>
<tr>
<td>Range of date</td>
<td>The search result will list out the range of date that the staff required.</td>
</tr>
<tr>
<td>Product ID</td>
<td>The search result will list out the TIU ID that the staff required.</td>
</tr>
<tr>
<td>Tree view</td>
<td>The search result will list out SIMS table data</td>
</tr>
</tbody>
</table>
3) Super user menu module

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid Login WWID, Login Password</td>
<td>Login is successful and the super user is represented with the Super user Menu.</td>
</tr>
<tr>
<td>Invalid Login WWID, Login Password</td>
<td>Login fails, World Wide ID and password do not match and an error message is displayed.</td>
</tr>
<tr>
<td>Valid Product ID, Product Name, Product Description, Product Duration, Product Pogo Pin Counter</td>
<td>The product is successfully added to product inventory.</td>
</tr>
<tr>
<td>Invalid Product ID, Product Name, Product Description, Product Duration, Product Pogo Pin Counter</td>
<td>The product already exists in the database, the super user is notified of the error and the product is not added to product inventory. On the other hand, the super user enters incorrect data or a required field is left blank, the super user is notified of the error and the product is not added to the product inventory.</td>
</tr>
<tr>
<td>Valid Supplier ID, Supplier Name, Supplier Company, Supplier Description, Supplier Email, Supplier Hand phone, Supplier Address</td>
<td>The supplier is added to the database.</td>
</tr>
<tr>
<td>Invalid Supplier ID, Supplier Name, Supplier Company, Supplier Description, Supplier Email, Supplier Hand phone, Supplier Address</td>
<td>The super user enters incorrect data or a required field is left blank. The super user is notified of the error and the supplier is not added to the database.</td>
</tr>
<tr>
<td>Valid User WWID, User Password, User Name, User Status, User Email, User Department, User Building, User Hand phone</td>
<td>The user is added to the database.</td>
</tr>
<tr>
<td>Invalid User WWID, User Password, User Name, User Status, User</td>
<td>The super user enters incorrect data or a required field is left blank. The super user is notified of the error and</td>
</tr>
<tr>
<td>Super user Menu Module</td>
<td></td>
</tr>
<tr>
<td>------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Input</strong></td>
<td><strong>Output</strong></td>
</tr>
<tr>
<td>Email, User Department, User Building, User Hand phone</td>
<td>the user is not added to the database.</td>
</tr>
</tbody>
</table>

4) Barcode printing module

**Table 5.9: Barcode printing module**

<table>
<thead>
<tr>
<th>Barcode Printing Module</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input</strong></td>
</tr>
<tr>
<td>Product ID</td>
</tr>
</tbody>
</table>

5) Generate report module

**Table 5.10: Generate report module**

<table>
<thead>
<tr>
<th>Generate Report Module</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input</strong></td>
</tr>
<tr>
<td>Report Criteria</td>
</tr>
</tbody>
</table>

5.2.4 Database Design

A database is a mechanism that used to store information or data. Information is something that used on a daily basis for a variety of reasons. During the development of SIMS Tools, data or information is stored in the database that
resides in the Microsoft Access 2000. The following sub section is discussing about the logical database design.

5.2.4.1 Logical Database Design

Below is an Entity Relationship Diagram (ERD) that used to develop for an Access database for the automated SIMS Tools software application. Within the tables are fields, Primary Keys and Foreign Keys, which allow information to be stored, transferred and manipulated depending on the properties.

![Figure 5.3: Overall SIMS Tools ERD](image)

The components of Entity Relationship Diagram consist of entity, relationship and cardinality:
Figure 5.4: ERD between Product and Supplier

1) In SIMS Tools system, the product may be owned by zero or one supplier. However, the supplier may own zero, one or many products.

Figure 5.5: ERD between Product and Transaction

2) In SIMS Tools system, the product may be recorded zero, one or many transactions. However, the transaction may record zero or one product.
3) In SIMS Tools system, the transaction may be operated by zero or one user. However, the user may operate zero, one or many transactions.

5.3 Detailed Design

Detailed design is refining the SIMS Tools of preliminary design into detailed data structure. The detailed designs of SIMS will be discussed using UML diagrams as software specification and data dictionary as physical database design. The following sub sections will discuss detailed about the mentioned designs.

5.3.1 Software Specification

The conceptual data design is prepared at the beginning of the project. There will be high level view of how the user sees the data. It is top down process and normally prepared using brainstorming approach.
SIMS Tools conceptual design will be demonstrated using Use Case modeling. A use case is a scenario that describes the use of SIMS system by an actor’s interaction to accomplish a specific goal. An actor is a user playing a role with respect to the SIMS system such as staff. The scenario is a sequence of steps that describe the interactions between an actor and the system. The use case model actually consists of the collection of all actors and all use cases.

The developer can design a set of scenarios that each identifies a thread of usage for the system to be constructed based on the user requirements using Use Cases. The Use Cases will essentially capture the system’s functional requirements from the users’ perspective. It will actively involve users in the requirements gathering process. In addition to that, it provides the basis for identifying major classes and their relationships in order to serve as the foundation for developing system test cases.

In fact, SIMS Tools system consists of three actors who are staff, super user and product inventory provided with a short illustration of the overall process flow of SIMS Tools system. These are intended to highlight the major tasks that each user will perform and to give a general idea of staff and super user interactions with the system.

The SIMS Tools software application contains five main modules which are Transaction Module, Search Module, Super user Menu Module, Barcode Printing Module and Generate Report Module. The functions of the SIMS Tools are Select Transaction Type, Search for Product, Login Super user Menu, Print Barcode and Generate Report. The Use Case Diagram (Appendix B) illustrates the overview of the SIMS Tools system conceptual design.

The staff and super user interact with the SIMS Tools software application through the GUI to search and modify the database. The product inventory is the
SIMS Tools application database which will contain all information pertaining to the Intel Corporation products. In addition, it will contain staff authorization records. It will also store information entered by staffs and super users and retrieve this information according to the specified criteria. The following narrative describes the staff and super user use cases:

Table 5.11: Explanations about use case flow diagram

<table>
<thead>
<tr>
<th>FUNCTION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
</table>
| Select Transaction Type       | ![Diagram] Staff Select Transaction Type Product Inventory  
Staff can select the transaction type such as check out, check in, routine maintenance (RM) and repair to perform the transaction operations. If the transaction is valid, then the transaction operation successful message will be displayed out. The product inventory will record the transaction status for the related product. |
| Search for Product            | ![Diagram] Staff Search for Product Product Inventory  
Staff can select the search criteria such as date, TIU ID and so on to search for the product by transactions or inventory. The searching operations will be done according to the range of date and retrieve the data from the product inventory. The search result list will be displayed out to staff for further product information. |
| Login Super user Menu         | ![Diagram] Super user Login Super user Menu Product Inventory  
Super user enters World Wide ID (WWID) and password into a GUI. If this information matches an entry in the user table in the database, the super user menu GUI will appear giving the super user further options. Super user can add/update/delete products, users and suppliers profiles. Super user can trigger |
<table>
<thead>
<tr>
<th>FUNCTION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Print Barcode</td>
<td>Super user must register to add the new product into the product inventory after login successfully. After adding the new product, the super user can select the new product ID and generate the product barcode. Super user can preview the generated barcode. Super user can print out the barcode ID using laser printer. Super user log out the system to terminate the access.</td>
</tr>
<tr>
<td>Generate Report</td>
<td>Super user can select generate statistic report after login successfully. The system will retrieve transaction information from the product inventory. Then the super user can select related information to generate report. Super user can save report, retrieve report and view report before printing out. Finally, super user can print the generated report. Super user log out the system to terminate the access.</td>
</tr>
</tbody>
</table>

Activity diagrams (appendix) are mostly used to show a sequential flow of events or activities performed in SIMS Tool system. Activity diagrams can also be used to describe use cases or interactions. The activity diagram consists of action states, which contain details of an activity to be performed. An action state will leave the state when the desired action has been performed.

The logical design will represent the SIMS Tools application’s data in details. It is a bottom up process and the purpose of logical design is to represent SIMS
Tools system application design, identifying any additional system objects, determining operations and data structures for all objects, validating relationships and interactions between objects and prototyping user interface objects.

The Class Model is a standard UML construct used to detail the pattern from which objects will be produced at run-time. A class is a specification that an object is an instance of a class. Classes may be inherited from other classes (that is they inherit all the behavior and state of their parent and add new functionality of their own), have other classes as attributes, delegate responsibilities to other classes and implement abstract interfaces.

The Class Model is at the core of object-oriented development and design. It expresses both the persistent state of the system and the behavior of the system. A class encapsulates state (attributes) and offers services to manipulate that state (behavior). The Class Diagram figure (Appendix C) showed the overview logical design of SIMS Tools. The Class Model describes the logical objects in the SIMS Tools system and the relationships. It is a rigorous model used to define the structure and construction of the system in a manner such that code may be written to implement the SIMS system.

The object interaction diagrams are used to fully define all required messaging between objects The Sequence Diagram presents the message traces of the application. Sequence Diagrams can be prepared in any phase of the development. The SIMS Tools logical design is captured in the following Sequence Diagrams. Please refer the Appendix for SIMS Tool Use Case Realization Class Diagrams as well as Sequence Diagrams.
5.3.2 Physical Database Design

The SIMS Tools software application database will be designed using Microsoft Access 2000. It can design custom databases that are flexible, perform well and are easy to maintain as well as manage. The main objective of the database design is to create a generic Inventory Management Database System, which will allow the user to keep track of the inventory according to the location and range of date in order to improve and streamline the Intel Corporation business processes.

Database design specifications are useful in a wide array of business applications. Some of the most common uses include:

1) To increase the efficiency of operations such as inventory stock control.

2) To provide statistics, summaries, forecasts by generated report.

3) To provide up-to-date and correct management information from any hierarchy level.

The Inventory Management Database System will be implemented using MS Access 2000 as the Database design tools with the appropriate SQL queries to alter, delete tables and also to add, delete and retrieve data. There are some proper procedures to create and design a sophisticated database:

1) Identify and create a table for entering the data.

2) Specify the name of field within a table and define how each field appears or handles data in the database.

3) Recognize and create a primary key for specific field.

4) Enter data directly into a blank datasheet. When the new datasheet has been saved, MS Access will analyze the data and automatically assign the appropriate data type and format for each field.

5) Define and create a relationship between tables.
5.3.2.1 Data Dictionary

The data dictionary provides an overview of the main data structures for the system in each and every database. The data dictionary is an organized listing of all data elements that are pertinent to the SIMS Tools system, with precise, rigorous definitions so that both user and developer will have a common understanding of inputs, outputs, components of stores and even intermediate calculations. Therefore, it is necessary to provide an organized approach for representing the characteristics of each data object and control item which is accomplished by the data dictionary.

The data dictionary is almost always implemented as part of a CASE “structured analysis and design tool”. The data dictionary improves the consistency of the analysis model when encompasses representations of data objects, function and control as well as helps to reduce errors.

In database management system, there will be a file that defines the basic organization of a database. The data dictionary contains a list of all files in the database, the number of records in each file and the names and types of each field. The database has tables for the various types of information such as Product, Supplier, Transaction and User.

1) Product Table

<table>
<thead>
<tr>
<th>Product Table</th>
</tr>
</thead>
<tbody>
<tr>
<td>ProductID</td>
</tr>
<tr>
<td>ProductName</td>
</tr>
<tr>
<td>Description</td>
</tr>
<tr>
<td>Duration</td>
</tr>
<tr>
<td>Inventory</td>
</tr>
</tbody>
</table>
The Product Table will store the products information including unique Product ID, Product Name and product availability in the Inventory data as well as keep the pogo pin counter.

2) Supplier Table

**Table 5.13: Supplier Table in SIMS database**

<table>
<thead>
<tr>
<th>Supplier Table</th>
</tr>
</thead>
<tbody>
<tr>
<td>SupplierID</td>
</tr>
<tr>
<td>Name</td>
</tr>
<tr>
<td>Company</td>
</tr>
<tr>
<td>Description</td>
</tr>
<tr>
<td>Email</td>
</tr>
<tr>
<td>Handphone</td>
</tr>
<tr>
<td>Address</td>
</tr>
</tbody>
</table>

The Supplier Table will store the suppliers’ information including unique SupplierID, Name and Email in order to trigger email for the suppliers accordingly.
3) Transaction Table

### Table 5.14: Transaction Table in SIMS database

<table>
<thead>
<tr>
<th>Transaction Table</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>WWID</td>
<td>Text(8)</td>
</tr>
<tr>
<td>ProductID</td>
<td>Text(25)</td>
</tr>
<tr>
<td>CheckOutDate</td>
<td>Date</td>
</tr>
<tr>
<td>CheckInDate</td>
<td>Date</td>
</tr>
<tr>
<td>Transaction</td>
<td>Text(15)</td>
</tr>
<tr>
<td>SystemNo</td>
<td>Text(15)</td>
</tr>
<tr>
<td>Description</td>
<td>Text(150)</td>
</tr>
</tbody>
</table>

The Transaction Table will store the unique WWID, unique Product ID, Check Out Date, Check In Date and Transaction so as to record all transaction operations.

4) User Table

### Table 5.15: User Table in SIMS database

<table>
<thead>
<tr>
<th>User Table</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>WWID</td>
<td>Text(8)</td>
</tr>
<tr>
<td>Password</td>
<td>Text(25)</td>
</tr>
<tr>
<td>Name</td>
<td>Text(50)</td>
</tr>
<tr>
<td>Status</td>
<td>Text(50)</td>
</tr>
<tr>
<td>Email</td>
<td>Text(25)</td>
</tr>
<tr>
<td>Department</td>
<td>Text(50)</td>
</tr>
<tr>
<td>Building</td>
<td>Text(10)</td>
</tr>
<tr>
<td>Handphone</td>
<td>Text(15)</td>
</tr>
</tbody>
</table>

The User Table will store the unique WWID, Password to login super user menu, Email in order to trigger email for the users accordingly.
5.4 Summary

The overall purpose of the design activity is to meet the needs of users, whether through the design of the products or services themselves, or through the design of the processes which will produce them. All the performance objectives of the operation such as quality, speed, dependability, flexibility and cost will be influenced by the design activity.

The design activity, therefore, is equally applicable to both product and service design and to process design. The object oriented design transforms the analysis model created using object oriented analysis into a design model that serves as a blueprint for software construction.

Finally, the initial design and prototyping phases of the SIMS Tools system will be planned from the user requirements point of view.
CHAPTER VI

IMPLEMENTATION

6.1 Introduction

This chapter will explain about the Spare Part Inventory Management System (SIMS) implementation phase after completed analysis and design phase. In software development, the implementation should follow the design and the resulting system in order to meet its requirements and performance goals, thus the conformance quality will be high.

During the implementation phase, the SIMS software design is realized as a set of programs or program units. For instance, the Graphical User Interface (GUI) will be implemented first or in parallel with the backend. One criterion is to write the code which can be easily maintained for future enhancement.

Efficient processing and operations management start with an integrated approach that links all facets of system management together. Inventory management is just one of the disciplines. Each augments the other, and provides the ability to effectively manage a large systems environment.
6.2 Software Development Environment Setup

To successfully implement SIMS software application which contains some of the main modules for instance transaction operation, super user menu login, inventory search, add/ update/ delete profiles, graph viewing, barcode and report printing, it is necessary to integrate it within the everyday functions performed by company personnel.

The software development environment setup section provides a detailed run down of the platform, required software components and programming language used to implement the SIMS software application. SIMS software application development environment is running on Windows XP which connecting to Access database to store all the inventory and transaction data. The figure 6.1 shows the development environment setup architecture.

---

![Diagram](image_url)

**Figure 6.1: Software Development Environment Architecture**
6.2.1 Implementation Software

The SIMS software will be implemented according to programming language, development environment, operation system and database. The following sub sections will be discussed in details.

6.2.1.1 Programming Language

The SIMS software application was written in Visual C++ 6.0 using Windows Forms functionality provided by Microsoft’s Visual Studio C++ Framework. C++ is a very powerful object oriented language developed specifically to mission-critical corporate application using Microsoft Visual C++ development system. Visual C++ is the most productive C++ tool used in the highest performance development for Windows. Windows Forms provides enhanced functionality for coding Windows application (http://www.asia.microsoft.com/msj/1098/default.aspx).

6.2.1.2 Development Environment

Visual C++ is designed specifically to target the Visual Studio framework. The Microsoft Visual C++ 6.0 must be present in order to program in Visual C++. The Visual C++ IDE simplifies many of the tasks of C++ programming as it provides support for debugging and project management of applications. For these reasons Visual C++ was chosen to develop SIMS software application.
6.2.1.3 Operation System

The intended operating system for the SIMS software application is Microsoft Windows. While the application was developed on a computer running Windows XP, it will run on any commercial version of Windows. Windows XP was chosen as it is one of the most reliable and robust versions of the Windows operating system family (http://www.microsoft.com/windowsxp/pro/evaluation/features.asp).

6.2.1.4 Database

Microsoft Access has been used as database to store user, supplier, product and transaction profiles. Microsoft Access provides a set of powerful tools to make accessing and sharing data easily. The database connection was done using Data Sources Open Database Connectivity (ODBC) to access the data from Access database management system. Data Sources (ODBC) will let users to run the same program to access data in an Access database. ODBC is a programming interface that enables applications to access data in database management systems that use Structured Query Language (SQL) as a data access standard.

The database administrator (DBA) needs to control database management function such as add in the whole product inventory to be stored into the database. Besides that, the DBA needs to define standard and procedures required to interact with the inventory database in order to ensure the inventory is maintained systematically (http://www.microsoft.com/office/access/prodinfo/overview.mspx).

In addition to that, the DBA should also adopt appropriate plan for continued inventory database development and maintenance. For instance, DBA must perform
technical and managerial duties to ensure proper operation of inventory database to support Intel Corporation manufacturing mission.

6.3 Implementation Status

The implementation status establishes the schedule and needed resources. It defines implementation details including programming language, platforms, programming environments, debugger and many more.

SIMS software application consists of five main modules such as Transaction Module, Super user Login Module, Search Module, Barcode Printing Module and Generate Report Module. This table provides a thumb-nail view of the status of the SIMS software application implementation for example module name, description, progress status, date completed and duration to complete.

Table 6.1: The implementation status of SIMS software application for each module

<table>
<thead>
<tr>
<th>Module</th>
<th>Description</th>
<th>Status</th>
<th>Date Completed</th>
<th>Duration To Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transaction</td>
<td>1. design interface</td>
<td>Completed</td>
<td>June 2004</td>
<td>2 days</td>
</tr>
<tr>
<td></td>
<td>2. create transaction functionality</td>
<td></td>
<td></td>
<td>4 days</td>
</tr>
<tr>
<td></td>
<td>3. create connection to database</td>
<td></td>
<td></td>
<td>1 day</td>
</tr>
<tr>
<td></td>
<td>4. testing the transaction functionality</td>
<td></td>
<td></td>
<td>2 days</td>
</tr>
<tr>
<td></td>
<td>5. debug and modify the design and coding</td>
<td></td>
<td></td>
<td>1 day</td>
</tr>
<tr>
<td>Module</td>
<td>Description</td>
<td>Status</td>
<td>Date Completed</td>
<td>Duration To Complete</td>
</tr>
<tr>
<td>-------------------</td>
<td>------------------------------------------------------------------------------</td>
<td>--------</td>
<td>----------------</td>
<td>----------------------</td>
</tr>
</tbody>
</table>
| Super user Login  | 1. design interface  
                    2. create login functionality  
                    3. create connection to database  
                    4. testing the login functionality  
                    5. debug and modify the design and coding | Completed | June 2004 | 1 day  
                            2 days  
                            1 day  
                            2 days  
                            1 day |
| Search            | 1. design interface  
                    2. create search by inventory and transaction functionality  
                    3. create connection to database  
                    4. testing the search functionality  
                    5. debug and modify the design and coding | Completed | July 2004 | 3 days  
                            6 days  
                            3 days  
                            2 days  
                            3 days |
| Barcode Printing  | 1. design interface  
                    2. create barcode printing and generate barcode functionality  
                    3. create connection to database  
                    4. testing the barcode printing and generate barcode functionality  
                    5. debug and modify the design and coding | Completed | July 2004 | 3 days  
                            5 days  
                            2 days  
                            2 days  
                            3 days |
| Generate Report   | 1. design interface  
                    2. create generate report and preview report functionality | Completed | August 2004 | 3 days  
                            4 days |
<table>
<thead>
<tr>
<th>Module</th>
<th>Description</th>
<th>Status</th>
<th>Date Completed</th>
<th>Duration To Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3. create connection to database</td>
<td></td>
<td></td>
<td>2 days</td>
</tr>
<tr>
<td></td>
<td>4. testing the generate report functionality</td>
<td></td>
<td></td>
<td>2 days</td>
</tr>
<tr>
<td></td>
<td>5. debug and modify the design and coding</td>
<td></td>
<td></td>
<td>2 days</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>62 days</strong></td>
</tr>
</tbody>
</table>

As the table indicates, the specific of five main modules had completely been developed under the appropriate software development environment. The SIMS software application took approximately 62 days to complete the five main modules.

### 6.4 Summary

The software development environment setup is the environment of tools and processes in order to enable efficient and reliable development, validation and releases of SIMS software application. The implementation of software included Microsoft Visual C++, Microsoft Access running on Windows XP during the software development.

The implementation status could be considered as part of the design, which is considered as the first accomplishment in the implementation phase. At the end of the implementation phase, the SIMS software application should be ready for delivery, subject to modification during integration and testing.
CHAPTER VII

TESTING

7.1 Introduction

Software testing frequently consumes most of the software lifecycle cost and any reduction in testing cost while maintaining software quality can lead to significant software cost reduction. The objective of the test activity is to ensure that the software conforms to the software requirements. The individual Spare Part Inventory Management System (SIMS) modules are integrated and tested as a complete system to ensure that the software requirements specification concerning the actual software for which the Intel Corporation manufacturing have been met. It is expected that after the test effort, the SIMS software system is delivered to the Intel Corporation Manpower Staffing to handle the test hardware inventory.

The testing activities will include preparation of the test plan to identify the items being tested, the features to be tested, the testing tasks to be performed, the personnel responsible for each task and the risks associated with the test plan. Besides that, the strategies will be selected for testing activity which is relatively efficient; they are time and cost effective. The test design will describe each test case specification and effectiveness.
7.2 Test Plan

Test plan is associated with each of the testing phases that the Application Under Testing (AUT) undergoes during its development life cycle. Test plan comprises of test organization, test environment, and test schedule which will be discussed in details.

7.2.1 Test Organization

The SIMS software application will be implemented at the Intel Corporation manufacturing production floor as the staffs encountered some issues such as Tester Interface Units (TIU) missing due to mishandling as the entire TIU are handling manually that caused many cases of damaged components affecting machinery downtime.

SIMS software application is developed in order to ensure the TIU handling process in control, reduce the damage to components, realize cost saving and reduce unnecessary downtime as well as man hour to repair. The software application will certainly improve the efficiency of manufacturing operations.

As a result of that, the SIMS software application will be tested on the target users such as PG6 manufacturing production floor Manpower Staffing Services (MS) without a usability expert being involved. They will perform the daily transaction operations for instance check out, check in, repair and routine maintenance (RM) for the TIU at the production floor.
7.2.2 Test Environment

The completed SIMS software application will be executed at the Intel Corporation manufacturing TIU room as the centralized control center to handle the entire product inventory. The hardware requirement must be equipped with a proper setup Personal Computer running on Windows XP operating system platform. Besides that, the developed software will be connected to the laser printer to print out the generated barcode. The barcode scanner will be used to scan the printed barcode for transaction use.

In addition to that, the SIMS software application will perform efficiently in Windows XP Professional. The other software requirement would be the Microsoft Visual Studio as the SIMS software application was developed using Visual C++ 6.0 which connected to the Microsoft Access 2000 database to store the entire product inventory data.

7.2.3 Test Schedule

Testing was conducted at the developer’s desktop to do the testing of functional requirements. After that, the SIMS software application will be implemented at Intel Corporation manufacturing TIU room after the SIMS software has been tested. During the SIMS application’s implementation, the feedback from the users will be collected. This table shows the test schedule that has recorded tasks, activities and duration to carry out the testing activities.
Table 7.1: Test schedule that has recorded tasks, activities and duration to carry out the testing activities

<table>
<thead>
<tr>
<th>Task</th>
<th>Activity</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Prepare the test plan.</td>
<td>2 days</td>
</tr>
<tr>
<td>2</td>
<td>Prepare the test specification. Identifies and defines the specific tests to be conducted.</td>
<td>2 days</td>
</tr>
<tr>
<td>3</td>
<td>Prepare the hardware test environment. Ensure test environment and assets are managed and maintained.</td>
<td>1 day</td>
</tr>
<tr>
<td>4</td>
<td>Prepare the software test environment. Ensure test data (database) environment and assets are managed and maintained.</td>
<td>1 day</td>
</tr>
<tr>
<td>5</td>
<td>Perform the test procedures. Identifies and defines the operations, attributes and associations of the test classes.</td>
<td>3 days</td>
</tr>
<tr>
<td>6</td>
<td>Resolve test incident reports. Implements and unit tests the test classes and test packages.</td>
<td>3 days</td>
</tr>
<tr>
<td>7</td>
<td>Repeat tasks (5) – (8) until all test procedures are successful.</td>
<td>7 days</td>
</tr>
<tr>
<td>8</td>
<td>Prepare the test summary report.</td>
<td>2 days</td>
</tr>
</tbody>
</table>

7.3 Test Strategy

Black-box testing and white-box testing has been selected as an approach to test the SIMS system as it will useful for object-oriented systems. Using these techniques will assist in designing test cases that validate the correctness of the SIMS system with respect to the requirements specification.
Black-box testing is an approach to testing where the program test cases are based on the system specification. There is no knowledge of software design used and tests are strictly based on requirements and functionality. It divided into three types of testing such as positive testing, negative testing and error guessing. The positive testing was designed to determine if a feature produces results that are consistent with the stated requirements when the SIMS software is used properly. In other words, the positive testing will test the user to enter valid input in the specific range of value.

However, the negative testing was designed to determine if the SIMS software behaves reasonably when faced with invalid inputs or unexpected operator actions. In other words, the negative testing will test the user to enter valid input which is not a positive value. Besides that, the error guessing will notify the user to enter valid input by prompting out the error message.

White-box testing is a derivation of test cases according to program structure. This testing is a method of testing in which knowledge of the software’s internal design is used to develop tests. As a result of that, this approach usually means that source code is examined to develop test cases. There are two types of testing for instance equivalence partitioning and boundary analysis. The equivalence partitioning will test the user to enter valid input in the range of value. For example the pogo pin counters only capture value in the range of 0 to 150000. If the value is more than 150000 units, the error message will be prompted out.

In addition to that, the boundary analysis will exercise specific limitations of the software, such as minimum and maximum values in order to determine if the software behaves reasonably. In other words, the boundary analysis will test the user to enter valid input which is more than 0 and less than 150000. If the input is invalid, the user will be notified by error message.
7.3.1 Classes of Tests

The black-box and white-box testing with tests derived from the specification is categorized as integration testing class. The testing will be implemented on the complete system or subsystem which composed of integrated components.

The white-box testing will be used for unit testing in order to find bugs in logic, data and algorithms in individual modules. White-box testing will be used to test the modules and procedures that support the modules. This technique ignores the function of the program under test and will focus only on its code and the structure of that code during unit testing. The unit test case shall be designed to test the validity of the program’s correctness.

On the other hand, the black-box testing techniques shall primarily be used at the system testing level. This technique is a comparison of the actual output with the specified output, regardless of the structure of the code or the code unit under test. After each successful installation of an approved module, a system test will be conducted. The system test cases shall ensure the functional or specification requirements are met. Test data or cases shall be derived from the specifications.

7.4 Test Design

Test design is discussing about the test that had been conducted in the testing phase of SIMS Tools. Test design comprises of test description and test data. Test description will describe about the testing technique that have been employed together with the test results and test data will illustrate the data that has been selected to run testing on SIMS Tools.
7.4.1 Test Description

The SIMS software application will be installed on the desktop that the connection to the database will be configured consequently. The testing will be carried out in order to identify the test cases and expected result for each module that is designed and documented. This table shows the purpose, test description and expected result that have been recorded.

Table 7.2: The purpose, test description and expected result that have been recorded

<table>
<thead>
<tr>
<th>Test Case ID</th>
<th>Purpose</th>
<th>Test Description</th>
<th>Expected Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>To test the transaction module in order to perform operations such as check out, check in, repair, routine maintenance (RM).</td>
<td>Open the main transaction interface and fill in the related information. After completed, select transaction types and click submit button.</td>
<td>If the information is valid, the “transaction successfully” message will pop up.</td>
</tr>
<tr>
<td>2</td>
<td>To test the super user login in order to access the super user menu.</td>
<td>Click the super user login button on main transaction interface to enter the World Wide ID (WWID) and password.</td>
<td>If the WWID and password are valid, the user can access the super user menu.</td>
</tr>
<tr>
<td>3</td>
<td>To test the search module in order to perform search by inventory and search by transaction.</td>
<td>Click the search at the toolbar and select search type as well as fill in some searching criteria.</td>
<td>If the searching criteria are valid, the search result will be listed out.</td>
</tr>
<tr>
<td>4</td>
<td>To test the barcode printing module in order to generate and print barcode.</td>
<td>Click the barcode at the toolbar and select product ID to generate barcode. Then click print from file menu to print generated barcode.</td>
<td>If the product ID is valid, the barcode will be generated. Then choose print to print the generated barcode.</td>
</tr>
<tr>
<td>5</td>
<td>To test the generate</td>
<td>Click the report at</td>
<td>If the information</td>
</tr>
<tr>
<td>Test Case ID</td>
<td>Purpose</td>
<td>Test Description</td>
<td>Expected Result</td>
</tr>
<tr>
<td>-------------</td>
<td>---------</td>
<td>-----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td></td>
<td>report module in order to generate and preview transaction report.</td>
<td>the toolbar and select report wizard from windows menu. The wizard will pop up and generate report accordingly. After completed, click print preview to preview the generated and choose print to print the generated report.</td>
<td>is valid, the report will be generated accordingly. Then choose print preview to preview it and choose print to print it.</td>
</tr>
</tbody>
</table>

7.4.2 Test Data

SIMS test data is the inputs which have been gathered to test the system. The test data will be selected for the five main modules such as transaction module, super user login module, search module, barcode printing module and generate report module. The entire SIMS software application’s real data is taken based on the Intel Corporation’s product inventory profiles. As a result of that, the completed SIMS software application can be implemented at the manufacturing production floor to adapt the real organizational environment. This table shows the test cases, test data and expected results that have been recorded.

Table 7.3: The test cases, test data and expected results that have been recorded

<table>
<thead>
<tr>
<th>Test Case ID</th>
<th>Test Data</th>
<th>Expected Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>User enters WWID, Product ID, Pogo Pin Counter and System Number; selects transaction type such as Check Out, Check In, Repair and RM at the transaction module.</td>
<td>The user is prompted transaction successfully and database has been updated if information is valid.</td>
</tr>
<tr>
<td>2</td>
<td>User enters WWID and password.</td>
<td>The user is granted</td>
</tr>
<tr>
<td>Test Case ID</td>
<td>Test Data</td>
<td>Expected Result</td>
</tr>
<tr>
<td>-------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>3</td>
<td>User selects Search from Toolbar and selects search type such as search by transaction and search by inventory. User enters Product ID, Product Name for search by inventory. However, user specifies Product ID, check out date and check in date for search by transaction.</td>
<td>The user is prompted with search results if the information is valid.</td>
</tr>
<tr>
<td>4</td>
<td>User selects Barcode from Toolbar and selects Product Name and Product ID to generate the barcode.</td>
<td>The user is previewed with the generated barcode.</td>
</tr>
<tr>
<td>5</td>
<td>User selects Report from Toolbar and enters Year, Month, Check In and Check Out to generate transaction report.</td>
<td>The user is previewed with the generated report.</td>
</tr>
</tbody>
</table>

### 7.5 Test Case Results

SIMS test case is the inputs to test the system and the predicted outputs from these inputs if the system operates according to its specification. The pass or fail criteria for interconnection of the SIMS software application in each of the module took place in the proper sequences and each of the application entities should be left in the appropriate state following the operation.

If errors are found during testing, the errors will be recorded and the testing will be continued either to the end or until a fatal error that does not allow continuing testing occurs. In either case, once testing is stopped, the problem recorded will be fixed and the whole test cases will be rerun. Once there is no error found during testing, the software will be tested by randomly selected staffs before it is delivered to the client. If two out of three staffs are able to run the software and able to obtain required results, then the software is “good enough to deliver”.

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<table>
<thead>
<tr>
<th>Test Case ID</th>
<th>Tester</th>
<th>Test Objective</th>
<th>Test Data</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Developer</td>
<td>To demonstrate that the system manipulates transaction operations and notifies the user with the transaction successfully message.</td>
<td>Enter valid WWID; Product ID; Pogo Pin; System Number; Select Transaction Type according the sequence; Click “Submit”.</td>
<td>OK</td>
</tr>
<tr>
<td>2</td>
<td>Developer</td>
<td>To demonstrate that the system notifies the user with the error message saying data invalid.</td>
<td>Enter invalid WWID; Product ID; Pogo Pin; System Number; Select Transaction Type not according the sequence; Click “Submit”.</td>
<td>Error message</td>
</tr>
<tr>
<td>3</td>
<td>Developer</td>
<td>To demonstrate that the system notifies the user with the login successfully message.</td>
<td>Enter valid WWID and password.</td>
<td>OK</td>
</tr>
<tr>
<td>4</td>
<td>Developer</td>
<td>To demonstrate that the system notifies the user with the error message on invalid login.</td>
<td>Enter invalid WWID and password.</td>
<td>Error message</td>
</tr>
<tr>
<td>5</td>
<td>Developer</td>
<td>To demonstrate that the system displays the user with the search result.</td>
<td>Enter valid search criteria such as Product Name, Product ID, Range of Check Out and Check In Date.</td>
<td>OK</td>
</tr>
<tr>
<td>6</td>
<td>Developer</td>
<td>To demonstrate that the system displays the user with the generated barcode and print it.</td>
<td>Enter valid Product ID.</td>
<td>OK</td>
</tr>
<tr>
<td>7</td>
<td>Developer</td>
<td>To demonstrate that the system displays the user with the generated transaction report and print it.</td>
<td>Enter valid criteria such as Year, Month, Range of Check Out and Check In Date.</td>
<td>OK</td>
</tr>
<tr>
<td>8</td>
<td>Users</td>
<td>To demonstrate the ease of use of the system.</td>
<td>Randomly selected staffs to log in to the system and 2 out of 3 staffs shall be able to complete</td>
<td></td>
</tr>
</tbody>
</table>

Table 7.4: The test case ID, tester, test objective, test data, result has been recorded
<table>
<thead>
<tr>
<th>Test Case ID</th>
<th>Tester</th>
<th>Test Objective</th>
<th>Test Data</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>proceed to the Event input screen without assistance. The time each staff uses to complete the process will be recorded.</td>
<td>the process within 5 minutes.</td>
<td></td>
</tr>
</tbody>
</table>

The criteria for evaluating the intermediate and final results of the test case are the range or accuracy over which an output can vary and still be acceptable. In addition to that, the conditions under which outputs are to be interpreted as indicating irregularities in input test data, in the test database or in test procedures also considered. From the range of scale 1-5, the users’ satisfaction about the functionality of the SIMS system is approximately 4 which are categorized as good. The users satisfied with the functionality system as the system has met their requirements. The developer’s satisfaction towards the SIMS system is about 3 which are categorized as satisfied since the system still need to be enhanced for future plan.
7.6 Summary

The testing chapter has discussed about the test plan and how the testing has been done and the results that has been recorded and reported. Besides that, the chapter also described the testing of individual modules of all sizes as well as testing of functionalities of the system to ensure that they met the user requirements.

The executed test plan has defined the testing necessary to establish quality of SIMS system. The system passes all tests in the test plan and considered to be completed with high quality. The more complete the coverage of the SIMS system, the higher is the confidence in the system and raises the quality. The functionality and interoperability of SIMS software application has been evaluated after carried out the test plan. Testing is another powerful tool for object-oriented development. Like other powerful tools, it produces the best results when applied at the right time to the right problem. After completed testing, training must be provided to the user in order to perform and operate the software application functionality in the proper way.
CHAPTER VIII

CONCLUSION

8.1 Observation On Weaknesses And Strengths

The Spare Parts Inventory Management System (SIMS) Tool has been integrated with the advanced and useful technology such as preview two-dimensional generated barcode before printing; sending email and displaying interactive graph on Windows screen in order to improve the existing SIMS web base application.

Besides that, the generated report wizard also included in order to allow the users to generate transaction report easily and effectively based on specific criteria such as annual report format, monthly report format as well as according to the range of date. These advanced technologies absolutely will develop and construct an extremely automated inventory management system at Intel Corporation manufacturing production floor.

However, there are some constraints that were determined during the SIMS project development work according to the functionality and the reliability. The SIMS project can only be implemented in one centralized control station. As a result of that, there is a single inventory tracking location (TIU room) supporting the service Intel Corporation Network Communication Operations (NCO) manufacturing production floor. Thus, the super user can only operate SIMS Tools at the TIU room.
The super users need to add staffs whose status are normal users to be upgraded to be super users in order to access the super user menu that may bring some inconveniences. The system authorizes types of users who are using the SIMS software. Whenever the super user is not available, the Barcode Printing Module cannot be executed at that moment. As a result of that, the new product has to be in a state of uncertainty since there is no barcode label on it.

8.2 Propositions For Improvement

The final stage of the SIMS will be developed as a stand alone software application that manage test hardware inventory at Intel Corporation NCO manufacturing production floor. The developed project actually duplicated the functionality of the existing SIMS web base application that was currently implemented at the production floor. There are some proposed features that have been enhanced to the system such as auto keep track of pogo pin counter due, interactive graph displayed, barcode printing integration, report wizard and others.

Nevertheless, the developed project still can be improved better to be the Local Area Network (LAN) software application intensity. As a result of that, the software can support multi location Spare Parts Inventory Management System. Currently the system is only handling the TIU room product inventory in one centralized control station. If the system could be LAN software application, the managers and group leaders can check the product inventory in the office without entering to the manufacturing production floor. Before a LAN software application can be done, the network speed at the production floor must be improved as it is slow, that is the reason why the SIMS Tools developed as a stand alone software application rather than as a LAN.
The developed project will be performed by two categories of users such as staffs and super users. The staffs can only execute Transaction Module. Yet, the super users can achieve Search Module, Super user Menu Module, Barcode Printing Module and Generate Report Module after login to access super user menu successfully. To access the Super user Menu, the staffs must consult from the super user's permission. This may due to the new product cannot be labeled with the barcode whenever in the absence of the super user. The system could write the log file every time there is a user login to the super user menu. Thus, all the users might be provided with the password to login to the super user menu.

8.3 Conclusion

The SIMS is an automation system for everyday product inventory management routines. The SIMS Tools contains five main modules such as Transaction Module, Search Module, Super user Menu Module, Barcode Printing Module and Generate Report Module. In general, it provides the following functionality:

1) Transaction Module
   a) Capture every transaction operations such as check in, check out, RM (Routine Maintenance) and Repair.
   b) Auto keep track of pogo pin counter due.

2) Super user Menu Module
   a) Super user login for database administration such as add/ update/ delete of users, suppliers and products as well as barcode printing.
   b) Send email to contact staffs and suppliers with attached file.
   c) Display interactive transaction operations graph such as Check Out and Check In.

3) Search Module
a) Search by transaction and inventory.

4) Barcode Printing Module
   a) Integrate barcode printing portion into this stand alone software.

5) Generate Report Module
   a) Generate report wizard to generate out the transaction report to be printed out.

The developed SIMS project will be extending according to the user requirements and system functionality. The complete SIMS project will have the following expected purpose:

1) The stand alone SIMS project definitely improves speed of processing data in order to perform the transaction operations.

2) The auto keep track of pogo pin counter due will reduce the productivity down time as well as realize the cost savings. Cleaning procedures will be carried out regularly when the counter exceeds 150000 units.

3) The interactive graph will be displayed to act as an indication about the summary of the product transaction operations based on range of date.

4) The system will integrate barcode printing with the software application to make the printing job more convenient and effective.

5) The system will generate transaction report using the report wizard that provides user guide sequentially.

6) Password protection for the SIMS security features in order to do some database administration work.

Intel Corporation inventory management is an enterprise-wide discipline concerned with the identification and tracking of Information Services (IS) hardware and software assets. The inventory management provides up-to-date information about data processing resources through the creation and archiving of records in a centralized repository. This will ensure efficient and timely identification of vital corporate assets so as to assist in managing the enterprise-wide inventory.
BIBLIOGRAPHY


States of America: Sams Publishing.


Steven, P.R. (1999). "A Practical Introduction to Software Design with C++." 1st


Investment Purchasing and Inventory Management Journal." Meeting the
Challenge of the 90s.

Noor Azilah Muda (2001). "Risk Management System." Universiti Teknologi
Malaysia: Tesis Sarjana Sains (Komputer Sains).
APPENDICES

APPENDIX A: SIMS TOOL GANTT CHART
<table>
<thead>
<tr>
<th>Task Name</th>
<th>Start Date</th>
<th>End Date</th>
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<tbody>
<tr>
<td><strong>Preliminary Investigation</strong></td>
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<tr>
<td>1. List Problems, opportunities and directives</td>
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<tr>
<td>2. Negotiate Scope</td>
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<tr>
<td>3. Plan the Project</td>
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<td><strong>Problem Analysis</strong></td>
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<td>7. Study the Problem Domain</td>
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<td>8. Analyze Problems and Opportunities</td>
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<tr>
<td>9. Analyze Business Processes</td>
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<td>10. Update the Project Plan</td>
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<td><strong>Requirements Analysis</strong></td>
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<td>12. Define Requirements</td>
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<td>13. Analyze Functional Requirements</td>
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<td>14. Trace and Complete Requirements</td>
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<td>15. Prioritize Requirements</td>
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<td>16. Update the Project Plan</td>
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<td><strong>Design</strong></td>
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<td>18. Design the Application architecture</td>
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<td>19. Design the System Interface</td>
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<td>20. Package Design Specification</td>
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<td>21. Update the Project Plan</td>
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<td><strong>Development and Implementation</strong></td>
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<td>24. Install and Test New Software Package</td>
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<td>25. Develop System and Coding</td>
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<td>26. Test System</td>
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<td>27. Train Users</td>
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<td><strong>System Testing</strong></td>
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<td>30. Unit Testing</td>
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<td>31. Module Testing</td>
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<td>32. User Acceptance Test</td>
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<tr>
<td>33. Operations Acceptance Test</td>
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<td><strong>Troubleshooting and Maintenance</strong></td>
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<td>36. Validate the Problem</td>
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<td>37. Benchmark Program</td>
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<td>38. Study and Debug the Program</td>
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<tr>
<td>39. Test the Program</td>
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</table>
APPENDIX B: USE CASE DIAGRAM
APPENDIX C: OVERVIEW CLASS DIAGRAM
MainApplicationMenu

- start()
- exit()

<<boundary>>
MainTransactionForm
- select transaction type()
- display transaction status()
- register for transaction()
- check out()
- check in()
- routine maintenance()
- repair()
- cancel()
- select check out()
- select routine maintenance()
- select repair()

<<boundary>>
SearchForProductForm
- search()
- display search result()
- select search criteria()
- display search status()
- display criteria invalid()
- cancel()

<<control>>
InventoryController
- is transaction valid?()
- is password valid?()
- get product()
- update transaction status()
- find product inventory list()
- is criteria valid?()
- generate product barcode()
- get report criteria()
- retrieve product information()
- print report()
- print barcode()

<<boundary>>
MainSuperuserMenu
- login()
- display possible operations()
- cancel()
- print barcode()
- select print barcode()
- display invalid password()
- select generate report()
- logout()

<<boundary>>
ProductInventoryForm
- preview generated report()
- print report()

<<boundary>>
BarcodePrintingForm
- preview generated barcode()

<<boundary>>
Printer
- print report()
- print barcode()
- untitled()
APPENDIX D: ACTIVITY DIAGRAM
D.1: Select Transaction Type Activity Diagram

Start

Select Transaction Type

select check out type

Check Out

select check in type

Check In

check completed

Place checkout on Product Inventory

record check out status

Update Transaction Status

End

select repair or routine maintenance

select repair type

Repair

select routine maintenance type

Routine Maintenance

check completed

Place checkin on Product Inventory

record check in status

Update Transaction Status

End
D.2: Search For Product Activity Diagram

\[
\text{Start} \quad \rightarrow \quad \text{Search for Product} \quad \rightarrow \quad \text{Get Name and Product ID} \quad \rightarrow \quad \begin{cases} \text{get invalid name and ID} \\ \text{get valid name and ID} \end{cases} \quad \rightarrow \quad \begin{cases} \text{Display Product Description} \\ \text{Display error message} \end{cases} \quad \rightarrow \quad \text{End} \quad \rightarrow \quad \text{End}
\]
D.3: Login Super user Menu Activity Diagram

Start
insert password

Verify Password

inserted valid password
inserted invalid password

Access Superuser Menu
Display error message

Log out

Terminate access
End

End
D.4: Print Barcode Activity Diagram

1. Start
2. Insert password
3. Verify Password
4. If inserted valid password, proceed to Access Superuser Menu; if inserted invalid password, proceed to Display error message.
5. Access Superuser Menu
6. Select Product ID
7. Generate barcode
8. Display Barcode Preview
9. Connect to printer
10. Print Barcode
11. Log out
12. Terminate Access
13. End
D.5: Generate Report Activity Diagram
APPENDIX E: CLASS DIAGRAM
E.1: Select Transaction Type (Use Case Realization) Class Diagram

- **MainTransactionForm**
  - select transaction type()
  - display transaction status()
  - register for transaction()
  - check out()
  - check in()
  - routine maintenance()
  - repair()
  - cancel()
  - select check out()
  - select routine maintenance()
  - select repair()

- **InventoryController**
  - is transaction valid()?
  - is password valid()?
  - get product()
  - update transaction status()
  - find product inventory list()
  - is criteria valid()?
  - generate product barcode()
  - get report criteria()
  - retrieve product information()
  - print report()
  - print barcode()

- **IPrductInventorySystem**
  - get product inventory list()
  - find product inventory list()
  - retrieve product information()

- **Staff**
  - (from Industry Artifact)

- **PartTimeStaff**
  - (from Industry Artifact)

- **FullTimeStaff**
  - (from Industry Artifact)

- **Product Inventory List**
  - (from Industry Artifact)

- **Product Inventory**
  - (from Industry Artifact)

- **Product**
  - (from Industry Artifact)
E.2: Search for Product (Use Case Realization) Class Diagram
E.3: Login Super user Menu (Use Case Realization) Class Diagram

[Diagram showing relationships and methods related to the Login Super user Menu]

- **MainSuperuserMenu** (from Inventory)
  - login()
  - display possible operations()
  - cancel()
  - print barcode()
  - select print barcode()
  - display invalid password()
  - select generate report()
  - logout()

- **Super User** (from Industry Artifact)
  - 0..1

- **InventoryController** (from Inventory)
  - 1
  - is transaction valid?()
  - is password valid?()
  - get product()
  - update transaction status()
  - find product inventory list()
  - is criteria valid?()
  - generate product barcode()
  - get report criteria()
  - retrieve product information()
  - print report()
  - print barcode()
E.4: Print Barcode (Use Case Realization) Class Diagram

![Class Diagram Image]
E.5: Generate Report (Use Case Realization) Class Diagram

```
<table>
<thead>
<tr>
<th>Method</th>
</tr>
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<tbody>
<tr>
<td>login()</td>
</tr>
<tr>
<td>display possible operations()</td>
</tr>
<tr>
<td>cancel()</td>
</tr>
<tr>
<td>print barcode()</td>
</tr>
<tr>
<td>select print barcode()</td>
</tr>
<tr>
<td>display invalid password()</td>
</tr>
<tr>
<td>select generate report()</td>
</tr>
<tr>
<td>logout()</td>
</tr>
</tbody>
</table>

```

```
<table>
<thead>
<tr>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>get transaction valid()</td>
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<tr>
<td>is password valid()</td>
</tr>
<tr>
<td>get product()</td>
</tr>
<tr>
<td>update transaction status()</td>
</tr>
<tr>
<td>find product inventory list()</td>
</tr>
<tr>
<td>is criteria valid()</td>
</tr>
<tr>
<td>generate product barcode()</td>
</tr>
<tr>
<td>get report criteria()</td>
</tr>
<tr>
<td>retrieve product information()</td>
</tr>
<tr>
<td>print report()</td>
</tr>
<tr>
<td>print barcode()</td>
</tr>
</tbody>
</table>
```
APPENDIX F: SEQUENCE DIAGRAM
F.1: Select Transaction Type Basic Flow Sequence Diagram

1: select transaction type()
2: is transaction valid?()
3: display transaction status()
4: select check out()
5: select routine maintenance()
6: select repair()

Sequence Diagram: Select Transaction Type / Basic Flow - Select Transaction Type (select check out)
Sequence Diagram: Select Transaction Type / Basic Flow - Select Transaction Type (select routine maintenance)
Sequence Diagram: Select Transaction Type / Basic Flow - Select Transaction Type (select repair)
F.2: Select Transaction Type (Select Check Out) Basic Flow Sequence Diagram

1: select check out()  
2: get product inventory list()  
3: get product inventory list()  
4: get product inventory list()  
5: display transaction status()  
6: check out()  
7: update transaction status()
F.3: Select Transaction Type (Select Routine Maintenance) Basic Flow Sequence Diagram

1: select routine maintenance()  
2: get product inventory list()  
3: get product inventory list()  
4: get product inventory list()  
5: display transaction status()  
6: check in()  
7: update transaction status()

F.4: Select Transaction Type (Select Repair) Basic Flow Sequence Diagram

1: select repair()  
2: get product inventory list()  
3: get product inventory list()  
4: get product inventory list()  
5: display transaction status()  
6: check in()  
7: update transaction status()
F.5: Select Transaction Type Alternate Flow Sequence Diagram

1: select transaction type()
2: is transaction valid()
3: display transaction status()
4: cancel()

F.6: Select Transaction Type Exception Flow Sequence Diagram

1: select transaction type()
2: is transaction valid()
3: display transaction invalid()
F.7: Search for Product Basic Flow Sequence Diagram

Sequence Diagram: Search for Product / Basic Flow - Search for Product (search)

F.8: Search for Product (Search) Basic Flow Sequence Diagram
F.9: Search for Product Alternate Flow Sequence Diagram

1: select search criteria() → 2: is criteria valid()?
3: display search status()
4: cancel()

F.10: Search for Product Exception Flow Sequence Diagram

1: select search criteria() → 2: is criteria valid()?
3: display criteria invalid()
F.11: Login Super user Menu Basic Flow Sequence Diagram

F.12: Login Super user Menu Alternate Flow Sequence Diagram
F.13: Login Super user Menu Exception Flow Sequence Diagram

F.14: Print Barcode Basic Flow Sequence Diagram
F.15: Print Barcode (Select Print Barcode) Basic Flow Sequence Diagram

F.16: Print Barcode Alternate Flow Sequence Diagram
F.17: Print Barcode Exception Flow Sequence Diagram

![](image1)

F.18: Generate Report Basic Flow Sequence Diagram

![](image2)
F.19: Generate Report (Select Generate Report) Basic Flow Sequence Diagram

F.20: Generate Report Alternate Flow Sequence Diagram
F.21: Generate Report Exception Flow Sequence Diagram

1: login()
2: is password valid?
3: display invalid password()
APPENDIX G: COLLABORATION DIAGRAM
G.1: Select Transaction Type Basic Flow Collaboration Diagram

1: select transaction type( )
4: select check out( )
5: select routine maintenance( )
6: select repair( )

2: is transaction valid( )

G.2: Select Transaction Type (Select Check Out) Basic Flow Collaboration Diagram

1: select check out( )
6: check out( )
2: get product inventory list( )
7: update transaction status( )

5: display transaction status( )

3: get product inventory list( )

Staff

MainTransactionForm

InventoryController

ProductInventory

ProductInventorySystem
G.3: Select Transaction Type (Select Routine Maintenance) Basic Flow Collaboration Diagram

G.4: Select Transaction Type (Select Repair) Basic Flow Collaboration Diagram
G.5: Select Transaction Type Alternate Flow Collaboration Diagram

1: select transaction type()
4: cancel()

3: display transaction status()

: Staff

: MainTransactionForm

2: is transaction valid()? 

: InventoryController

G.6: Select Transaction Type Exception Flow Collaboration Diagram

1: select transaction type()

3: display transaction invalid()

: Staff

: MainTransactionForm

2: is transaction valid()? 

: InventoryController
G.7: Search for Product Basic Flow Collaboration Diagram

G.8: Search for Product (Search) Basic Flow Collaboration Diagram
G.9: Search for Product Alternate Flow Collaboration Diagram

G.10: Search for Product Exception Flow Collaboration Diagram
G.11: Login Super user Menu Basic Flow Collaboration Diagram

1: login()

: Super User

3: display possible operations()

: MainSuperuserMenu

2: is password valid?()

: InventoryController

G.12: Login Super user Menu Alternate Flow Collaboration Diagram

1: login()
4: logout()

: Super User

3: display possible operations()

: MainSuperuserMenu

2: is password valid?()

: InventoryController
G.13: Login Super user Menu Exception Flow Collaboration Diagram

1: login()

: Super User

: MainSuperuserMenu

3: display invalid password()

2: is password valid?()

: InventoryController

G.14: Print Barcode Basic Flow Collaboration Diagram

1: login()

: Super User

: MainSuperuserMenu

4: select print barcode()

3: display possible operations()

2: is password valid?()

: InventoryController
G.15: Print Barcode (Select Print Barcode) Basic Flow Collaboration Diagram

1: select print barcode()

2: generate product barcode()

3: generate product barcode()

4: generate product barcode()

5: preview generated barcode()

6: print barcode()

7: print barcode()

: Super User

: BarcodePrintingForm

: InventoryController

: Printer

: IBarcodePrintingSystem

: Product Inventory
G.16: Print Barcode Alternate Flow Collaboration Diagram

```
3: display possible operations()

1: login()
4: logout()

: Super User

: MainSuperuserMenu

2: is password valid?()

: InventoryController
```

G.17: Print Barcode Exception Flow Collaboration Diagram

```
3: display invalid password()

1: login()

: Super User

: MainSuperuserMenu

2: is password valid?()

: InventoryController
```
G.18: Generate Report Basic Flow Collaboration Diagram

1: login()
2: is password valid()
3: display possible operations()
4: select generate report()

: Super User

: MainSuperuserMenu

: InventoryController
G.19: Generate Report (Select Generate Report) Basic Flow Collaboration Diagram

1: select generate report()

2: retrieve product information()

5: preview generated report()

7: print report()

3: retrieve product information()

4: retrieve product information()

6: print report()

: ProductInventoryForm

: InventoryController

: Printer

: ProductInventorySystem

: Super User

: Product Inventory

G.20: Generate Report Alternate Flow Collaboration Diagram

1: login()

3: display possible operations()

4: logout

2: is password valid?()

: Super User

: MainSuperuserMenu

: InventoryController
G.21: Generate Report Exception Flow Sequence Diagram

1: login()

: Super User

2: is password valid?()

: InventoryController

3: display invalid password()
APPENDIX H: SIMS TOOL INTERFACE DESIGN
H.1: Transaction Module interface design

H.2: Super user Menu Module (Login) interface design
H.3: Super user Menu Introduction interface design

H.4: Search Module interface design
H.5: Barcode Printing Module interface design

H.6: Generate Report Module interface design
H.7: Generate Graph interface design
APPENDIX I: PSEUDOCODE
I.1: Transaction Module

1) OnClose function
   a) Message box equal to "Are you sure you want to exit SIMS Transaction System?"
   b) If resp equal to IDYES, then exit.

2) OnSubmit function
   a) m_user open connectivity to database; m_transaction open connectivity to database; m_product open connectivity to database.
   b) While m_user is not end of file, if database WWID equal to user WWID, x equal to 1. While m_product is not end of file, if database ProductID equal to user ProductID, y equal to 1.
   c) Else if m_pogopin greater than 150000, then m_error1 equal to "The Pogo Pin Exceeded 150 000 Units! The Pogo Pin Must Be Changed!". Else if m_type equal to 0, while m_transaction is not end of file, if database WWID equal to user WWID and database ProductID equal to user ProductID, if m_Transaction equal to "RM" or m_Transaction equal to "REPAIR", then value equal to 1.
   d) If value equal to 0, then m_error1 equal to "Please select Repair or RM before Checkin". Else if m_type equal to 2 or m_type equal to 1, while m_transaction is not end of file, if database WWID equal to user WWID and database ProductID equal to user ProductID, if m_Transaction equal to "CHECK OUT", value equal to 2.
   e) If value equal to 0, then m_error1 equal to "Please CheckOut before RM or Repair". Else if m_type equal to 3, while m_transaction is not end of file, if database WWID equal to user WWID and database ProductID equal to user ProductID, then j equal to 1. If m_Transaction is not equal to "CHECK IN", then i equal to 1.
   f) If i equal to 1, then m_error1 equal to "Please CheckIn before CheckOut again!". Else, m_out equal to 1. If value equal to 1 or value equal to 2 or m_out equal to 1. If x equal to 1 and y equal to 1.
   g) If m_type equal to 3 and j equal to 0, then add new m_transaction database. Else if m_type equal to 3 and j equal to 1, while m_transaction
is not end of file, if database WWID equal to user WWID and database ProductID equal to user ProductID, edit m_transaction database.

h) m_user connectivity to database closed. m_transaction connectivity to database closed. m_product connectivity to database closed.

I.2: Search Module

1) OnRetrieve function
   a) Product open connectivity to database. While Product is not end of file, j equal to 0. If Product is end of file, break. Product connectivity to database closed.

2) OnEditUpdate function
   a) If m_windowstate equal to "EQUIPMENT", then call product_function. Else if m_windowstate equal to "TIME", then call transaction_function. Else if m_windowstate equal to "TABLE", if m_search equal to "User", then call user_function.
   b) Else if m_search equal to "Product", then call product_function. Else if m_search equal to "Supplier", then call supplier_function. Else if m_search equal to "Transaction", then call transaction_function. Else if m_windowstate equal to "ITUID", then call product_function.

3) OnEditDelete function
   a) If m_windowstate equal to "EQUIPMENT", then call product_function. Else if m_windowstate equal to "TIME", then call transaction_function. Else if m_windowstate equal to "TABLE", if m_search equal to "User", then call user_function.
   b) Else if m_search equal to "Product", then call product_function. Else if m_search equal to "Supplier", then call supplier_function. Else if m_search equal to "Transaction", then call transaction_function. Else if m_windowstate equal to "ITUID", then call product_function.
I.3:  Super User Login Module

1)  OnSuperLogin function
   a)  If dlgsuperlogin has been invoked, then m_user open connectivity to
database. While is not m_user end of file, then check if user WWID and
password equal to database WWID and password. m_user connectivity to
database closed.

I.4:  Barcode Printing Module

1)  OnDraw function
   a)  For m_count; m_count greater than m_hcount; m_count increment by 1.
If mm_cx less than (m_cx-200), then call DrawCode39Barcode function.
Else, then mm_cx equal to 20, m_count decrement by 1.

2)  OnAdd function
   a)  If j not equal to -1 and m_bar_name not equal to empty, then m_num
equal to str. Else if m_bar_name equal to empty, then message box equal
to "Please Enter Barcode Name". Else, message box equal to "Please
Select Quantity Barcode".

3)  OnReset function
   a)  Message box equal to "Yes To Delete All No to cancel delete". If is not
g_pDlgBarcode, then mm_cx equal to 20. mm_cy equal to 40. m_count
equal to 0.

4)  OnClose function
   a)  Message box equal to "The Data Configuration delete?".

I.5:  Generate Report Module

1)  OnWindowToolsReportwizard function
   a)  m_type equal to RPage2.m_type. m_trans_type equal to
RPage3.m_trans_type. m_a_year equal to RPage3.m_a_year. m_m_year
equal to RPage3.m_m_year. m_m_month equal to RPage3.m_str_month.
m_checkin equal to RPage3.m_checkin. m_checkout equal to RPage3.m_checkout. m_dt1 equal to RPage3.m_dt1. m_dt2 equal to RPage3.m_dt2.

2) OnWizardFinish function
   a) If m_trans_type equal to 0, then value equal to 1. Else if m_trans_type equal to 1, then value equal to 1. Else, then message box equal to "Please enter Data correctly".

3) OnDraw function
   a) m_transactionset open connectivity to database. If time_checkin equal m_a_year or time_checkout equal to m_a_year, then add m_WWID. If time_checkin equal to m_m_year and month1 equal to m_m_month or time_checkout equal to m_m_year and month2 equal to m_m_month, then add m_WWID.
   b) If time2 equal to empty, if time_checkin equal to time1 or time_checkout equal to time1, then add m_WWID. If time_checkin greater than time1 and time_checkin less than time2 or time_checkout greater than time1 and time_checkout less than time2, then add m_WWID. m_productset open connectivity to database.
   c) While m_productset is not end of file, then add m_ProductID. m_productset connectivity to database closed. m_userset open connectivity to database. While m_userset is not end of file, then add m_WWID. m_userset connectivity to database closed. m_supplierset open connectivity to database. While m_supplierset is not end of file, then add m_SupplierID. m_supplierset connectivity to database closed. m_transactionset open connectivity to database.
   d) While m_transactionset is not end of file, then add m_WWID. m_transactionset connectivity to database closed.
APPENDIX J: SIMS TOOL USER MANUAL
1) Main Transaction Page

a) Transaction Page will be the main page of Spare Part Inventory Management System (SIMS) Tool. The staff can perform transaction operations such as Check Out, Check In, Routine Maintenance (RM) and Repair.

b) The staff must fill in all the columns such as WWID (World Wide ID), Product ID, Pogo Pin, System Number as well as select transaction type such as Check Out, Check In, Repair or RM. Then, the staff may click “Submit Transaction” button to submit the transaction.

c) If the transaction has been done successfully, the “Transaction Successful” message will be displayed.
d) The staff can click "Demo" button to view the demonstration of how to perform the transaction operations.

e) The staff can click "Super User Login" button to login to the super user menu.

f) The staff can click "User Manual" to view how to use the SIMS Tool in a proper manner.
g) The staff can click "Exit" button to exit from the SIMS system.

2) Super User Menu

a) After the staff login successfully by enter the valid WWID and password, the SIMS Intro View will be displayed to the staff as welcome banner to access Super User Menu.
b) Now, the staff can act as super user like administrator to add user, product and supplier profiles. The super user can click "Add" button from the menu toolbar. The Add Profile dialog box will pop up as shown in figure.

![Add Profiles Dialog Box](image)

c) The super user must fill in all the related columns. After the super user has done the fill in job, then super user can click "Add" button to add all the profiles into database.

d) The super user can click "About" button from the menu toolbar to view the SIMS Scrolling Credits.

![SIMS Scrolling Credits](image)
3) Search View

a) Super user can select “Search” from the menu toolbar to search by transaction and search by inventory.

b) When super user selects “Transaction” from search type, search by date and search by table sections are available.

c) If super user selects “Inventory” from search type, search by equipment, search by product ID and search by table sections are available.
d) Super user can select “Inventory” from search type to perform search by equipment section. The user can click “Retrieve” button to retrieve entire product name data. After that, the user can select specific product name and click “Search” button.

![Search By Equipment](image)

Select The Equipment and click search button below

- Retrieve
- Search

e) The selected product name information will pop up in the search list after clicked “Search” button.

![Search Result](image)

f) The super user can right click selected row of data to perform update or delete operation by selecting “Update” or “Delete” menu. If super user clicked “Update” menu, the update profiles dialog box will pop up.
g) The super user can modify the data from the pop up window, after modification has been done, the user can click “Update” button to save new setting for data.

h) Otherwise, click “Delete” from menu to delete the selected data.

i) Super user can select “Transaction” from search type to perform search by date section. The user can select the range of date from search by date when the section is available. A “Date Picker” will pop up to select specific range of date to generate search list.

j) After selected the specific range of date, the user can click “Search” button to display the search result.
k) Super user can select “Inventory” from search type to perform search by product ID section. The user must key in specific product ID at the column search by product ID.

![Search by Product ID](image)

l) After key in specific product ID, click “Search” button and the search result will pop up.

![Product Table](image)

m) Super user can select “Inventory” or “Transaction” from search type to perform search by table section. The user can select either “User”, “Product”, “Supplier” or “Transaction” Table to generate the search list.
n) After selected specific table, click “Search” button to display the search result.

o) Super user can select any specific user data from the search list and click “Tools > Call” from the menu toolbar in order to invoke phone dialer to contact the user talking through the phone.
p) Super user can also select any specific user data from the search list and click “Tools > Email” from the menu toolbar in order to send email.

q) The send email window will pop up, the user can click at side of file column to attach file before send email to specific user.
r) Before sending the email to the user, the super user must click "Configuration" button to configure the email account in Outlook.

s) Finally, after all configurations have been done, just click "Send" button to send email.

4) Barcode View
a) Super user can select "Barcode" from the menu toolbar to generate and print product ID barcode.
b) The barcode configuration window will be floating at the corner of the main window.

c) When the user clicked “Barcode name” button, the product list will be displayed in the search list.

d) After selected the product ID to be generated as barcode from the search list, the product ID will appear at the barcode name column in barcode configuration.

e) The super user must select “Quantity” combo box from the barcode configuration for how many barcode to be printed.
f) If super user wants to preview generated barcode after clicked “Add” button, the user just checked “Preview One Screen”. After that, clicked “Display” button to preview generated barcode on screen.

g) The super user can click “Advanced” button to confirm height, width and ratio of preview generated barcode.
h) After that, super user can click “Apply” to confirm the data setting or cancel to set as default setting.

i) The super user can click “Reset” button on the barcode screen to clear all the generated barcode.

j) After generated the barcode, the super user can click “File > Print” to print barcode preview from file menu.

5) Report View

a) Super user can select “Report” from the menu toolbar to generate and print product ID barcode.

b) Super user can select “Window > Tools > Report Wizard” from file menu, then the report wizard window will pop up.
c) The welcome to report wizard banner will be displayed, just click “Next” button to proceed.

![Report Wizard]

To continue, click Next.

---

d) The Transaction Report will be generated after the “Next” button is clicked.

e) Before generate the report, the super user must specify some criteria such as Annual Transaction Report; Month Transaction Report or Other Transaction report based on range of date.

![Report Wizard Time]

- **Annual Transaction Report**: 
  - “year” (e.g., 2004)

- **Month Transaction Report**: 
  - “month”
  - “year” (e.g., 2004)

- **Other Transaction**
  - From: 12/30/1999
  - To: 12/30/1999

To close this wizard and proceed with the choice you selected, click Finish.
f) Besides that, the super user can also select “Window > Tools > Report Table” from file menu, the report table window will pop up.

g) The super user can click “User Table Report” button to generate entire user profiles report; click “Transaction Table Report” button to generate entire transaction operations history report; click “Supplier Table Report” button to generate entire supplier profiles report as well as click “Product Table Report” button to generate entire product inventory profiles report. Moreover, click “Transaction Report Wizard” button will link to report wizard window and click “Close” button will close the report table window.

h) Below is the example of user table report.
i) The super user can click “Reset” from the menu toolbar to clear the generated preview report.

j) Before printing the generated report, the user can click “File > Print Preview” from file menu to preview generated report.

k) The super user can click “File > Print” from file menu to print generated report.

l) Besides generating and printing report, the generated report can be exported in Excel File Format.
6) **Graph View**

a) Super user can select “Graph” from the menu toolbar to generate and print transaction graph based on range of date.

b) The date picker will always be floating at the corner of the window.

c) The user can select the range of date within 7 days in the same month.

d) The user can drag the date picker to generate transaction graph.

e) The default type of graph is line graph.
f) The user can click “Chart Type” button to convert the graph into line, column and combination of line and column graph.

7) Browser View

a) Super user can select “Browser” from the menu toolbar to view Intranet and Internet web page.

b) The default page will be SIMS Abstract.

c) Just type the URL address at the navigation column to navigate the specify web page.

d) Select “Back” to back; “Forward” to forward; “Home” to back default page; “Refresh” to refresh the pages and “Stop” to stop page loading.
SPARE PARTS INVENTORY MANAGEMENT SYSTEM (SIMS)  
ABSTRACT

During the industrial training at Intel Technology Sdn Bhd, the Spare Parts Inventory Management System tool web-based application has been implemented for Tenter Interface Unit Tracking System in the manufacturing production floor in order to ensure the parts handling process is in control, no damage to components, cost saving and reduce unnecessary downtime, man hour to repair and improve the productivity. The implementation actually is to set up one central location with Personal Computer database to manage issuing, returning, maintaining and close monitoring of all the Tenter Interface Unit components. More inputs need to be gathered for improvement on system, process, cost, productivity and others. Based on the feedbacks throughout the verification, there are some concerned areas about the Spare Parts Inventory Management System that need to be improved such as the network speed, barcode printing integration, efficiency of the existing system, some proposed key features and others. The enhanced software project will be developed to replace the existing web-based application due to some issues that always brought inconveniences and problems, which have been affecting the current system as well as the productivity. Intel Corporation can achieve typical benefits such as increase annual sales, reduce annual cost savings and reduce inventory costs through the improved software project. The Waterfall Software Development Model has been applying on the developed software project that will address those efficiency issues effectively according to the right project methodology and system requirement. Finally, this is a precious dream-come-true opportunity collaboration between National Technical University College Of Malaysia and Intel Corporation working closely on this project not only for Intel’s manufacturing production floor enhancement but also to boost up University College reputation and bring out the best public image. This will certainly make University College a good fame for improving Intel Corporation manufacturing production floor system.
APPENDIX K: USER QUESTIONNAIRE
KOLEJ UNIVERSITI TEKNIKAL KEBANGSAAN MALAYSIA
FAKULTI TEKNOLOGI MAKLUMAT DAN KOMUNIKASI

BITU 3893
PROJEK SARJANA MUDA
(PSM)

USER QUESTIONNAIRE ON
SPARE PARTS INVENTORY MANAGEMENT SYSTEM (SIMS) TOOLS SYSTEM

<table>
<thead>
<tr>
<th>Organization Name</th>
<th>__________________________</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>__________________________</td>
</tr>
<tr>
<td>Tel/Fax</td>
<td>__________________________</td>
</tr>
<tr>
<td>Web site</td>
<td>__________________________</td>
</tr>
<tr>
<td>E-mail Address</td>
<td>__________________________</td>
</tr>
<tr>
<td>Contact Person</td>
<td>__________________________</td>
</tr>
</tbody>
</table>
User Satisfaction in using Spare Parts Inventory Management System (SIMS)
Tools of Intel Corporation NCO manufacturing production floor

SIMS Tools has been implemented since December 2003 at PG6 manufacturing production floor for Tester Interface Units (TIU) tracking process. Please provide suggestions to improve the functionality and usability of current system to fulfill the needs of all users.

1. What problems are you facing when using the SIMS web-based system?
   □ Database connection
   □ Network speed slow
   □ No integration of barcode
   □ No E-mail triggering
   □ No interactive graph
   □ No auto keep track of pogo pin counter
   □ Others: _______________________

2. What do you think about the lay-out of current SIMS web-based system?
   a. Information access
      □ Very good
      □ Good
      □ Fair
      □ Poor
   b. Navigation tools
      □ Very good
      □ Good
      □ Fair
      □ Poor
   c. Interface color design
      □ Very good
      □ Good
      □ Fair
      □ Poor
   d. User guides
      □ Very good
      □ Good
      □ Fair
      □ Poor

3. What is your suggestion?
   □ Improve Database Connection
   □ Add E-mail triggering
   □ Integrate barcode printing with software
   □ Add Interactive graph
   □ Add auto keep track of pogo pin counter
   □ Others: _______________________

Thank you for your kind assistance
KUTKM and Intel Corporation.
April 2004.
APPENDIX L: ORGANIZATIONAL DATA COLLECTION APPROVED LETTER
FAKULTI TEKNOLOGI MAKLUMAT & KOMUNIKASI

Kan Kami (Our Ref): KUTKM.25/13.11/3 Jld. 2 (129) 14 April 2004

Kepada Sesap legacy Yang Berkenna

Tuan,

MEMOHON MENDAPATKAN MAKLUMAT DAN KAJIAN KES UNTUK MENYIAPKAN TUGASAN PROJEK SARJANA MUDA 1

Dengan hormatnya saya merujuk perkara di atas.

1. Dimaklumkan bahawa penama tersebut adalah pelajar Kolej Universiti Teknikal Kebangsaan Malaysia. Maklumat terperinci adalah seperti berikut:
   
   | Tama    | Gan Chun Hou |
   | No. Matrik | B030110025 |
   | Jurusus | Sarjana Muda Teknologi Maklumat & Komunikaksi  |
   | (Pembangunan Perisian) | |
   | Fakulti | Fakulti Teknologi Maklumat & Komunikasi |

2. Beliau perlu menyiapkan satu tugas dan projek bagi mata pelajaran Projek Sarjana Muda 1 (BITU 3973). Sehubungan dengan ini, saya sangat berbesar hati sekiranya pihak tuan dapat memberi peluang kepada pelajar ini untuk membuat kajian kes tersebut di organisasi tuan.

Negala kerjasama daripada pihak tuan didahului dengan ucapan terima kasih.

Selamat.

KOMPETENSI TERAS KEGEMILANGAN’
BERKHIDMAT UNTUK NEGARA’

Saya yang menurut perintah,

AHMAD FADZLI NIZAM BIN ABDUL RAHMAN

Penolong Pendaftar
Fakulti Teknologi Maklumat & Komunikasi,
Kolej Universiti Teknikal Kebangsaan Malaysia,

p. Dekan.